TM 11-5820-215-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

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~~FIELD~~ AND DEPOT
MAINTENANCE MANUAL

MODULATOR-OSCILLATOR GROUP OA-2180/FRT-51

HEADQUARTERS, DEPARTMENT OF THE ARMY

JULY 1960

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the dc circuits,

or on the 115/230 ac line connections.

DON'T TAKE CHANCES!

WHEN THIS EQUIPMENT IS USED AS PART OF RADIO TRANSMITTING SET AN/FRT-51, DANGEROUS VOLTAGES ARE EXPOSED AT THE RF OUTPUT METERS AND AT THE TRANSMISSION LINE ANTENNA COUPLER TERMINALS.

TECHNICAL MANUAL No. 11-5820-215-35

HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *15 July 1960*

FIELD AND DEPOT MAINTENANCE-MANUAL
MODULATOR OSCILLATOR GROUP
OA-2180/FRT-51

CHAPTER 1

BLOCK DIAGRAM THEORY

Section I. GENERAL

1. Scope

a. This manual covers field and depot maintenance of Modulator-Oscillator Group OA-2180/FRT-51. It includes instructions for third, fourth, and fifth echelons for troubleshooting, testing, alineing, repairing the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in paragraphs 8 through 106.

b. The complete technical manual for this equipment includes:

TM 11–5821–212–10, Radio Transmitting Set AN/FRT–51, Operator's Manual.

TM 11–5821–212–20, Radio Transmitting Set AN/FRT–51, Organizational Maintenance.

TM 11–5820–215–20P, Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart, Modulator-Oscillator Group OA–2180/FRT–51.

TM 11–5820–215–35P, Field and Depot Maintenance Repair Parts and Special Tools List for Modulator-Oscillator Group OA–2180/FRT–51.

c. For applicable forms and records, see paragraph 2, TM 11–5821–212–10.

Supsd C3 ~~*d.* Forward comments on this manual directly to the Commanding Officer, U.S. Army Signal Publications Agency, Fort Monmouth, N.J.~~

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2. Application

When used independently, Modulator-Oscillator OA–2180/FRT–51 (referred to throughout this manual as the Modulator-oscillator) serves as a source of an extremely stable radiofrequency (RF) signal that is continuously variable within the range of 1.7 to 32.3 megacycles (mc). When the modulator-oscillator is used as part of Radio Transmitting Set AN/FRT–51, it provides the transmitting set with facilities to accept two input lines carrying voice or audiofrequency telegraph signals (or multiple channels of either or both with suitable multiplexing equipment) and drives Radio Frequency Amplifier AM–1154A/G (part of the transmitting set) to produce twin- or single-sideband transmission.

Section II. MODULATOR-OSCILLATOR

3. Simplified Block Diagram

(fig. 1)

a. Voice frequency (vf) speech or telegraph signals are applied to the twin-sideband (tsb) modulator. These signals are combined with a 100-kilocycle (kc) carrier signal and produce upper- and lower-sidebands. These signals are heterodyned with a 400-kc signal to produce a 300-kc twin-sideband signal that is applied to the exciter-monitor.

b. The frequency standard develops frequencies of 1, 4.5, 5, 100, and 250 kc from a 1-mc crystal oscillator and divider circuits. A portion of the 100-kc output is applied to the tsb modulator where it is mixed with the audio input signal. All the output frequencies of the frequency standard are applied to the exciter-monitor.

c. The 300-kc twin- or single-sideband (ssb) signal from the tsb modulator is applied to the exciter-monitor in addition to the frequencies from the frequency standard. Mixer and multiplier circuits are used in the exciter-monitor to produce a 1.7-32.3-mc twin- or single-sideband signal that is used to excite Radio Frequency Amplifier AM–1154A/G (TM 11–5821–212–10).

d. The input line voltage (117 or 220 volts ac) is applied to the automatic line voltage control panel. The output of this panel is a closely regulated 115 volts ac that is applied to the power supply chassis. The power supply control panel controls the application of filament and plate power. The power supply chassis provides the correct operating potentials to all the units in the modulator-oscillator.

4. Twin-Sideband Modulator

(fig. 2 and 3)

The twin-sideband modulator contains modulator and frequency circuits for producing a 300-kc twin-sideband signal. Each of the audiofrequency input signals is combined with a 100-kc carrier signal (from the frequency standard compartment) in a balanced modulator circuit to form upper- and lower-sidebands. After filtering the undesired sideband from each balanced modulator these separate signals are combined to form a suppressed carrier twin-sideband signal with an upper-sideband (usb) having information from one audio input and a lower-sideband having information from the other audio input. A controlled amount of 100-kc carrier can be combined with the suppressed carrier tsb signal at this point as desired. The tsb signal is heterodyned with a 400-kc frequency to produce a 300-kc twin-sideband signal which is applied to the exciter-monitor compartment.

a. Audiofrequency signals from each input line are applied to separate balanced modulator circuits (CR205, CR206, CR207, and CR208) through sideband selector switches and sideband interchange relay K4001 that can place the audio on the desired sideband (upper or lower). The 100-kc signal from the frequency standard is amplified by V201 and applied to a square wave generator, CR201 through CR204. One output from the square wave generator is applied to square wave amplifier V202 and then to balanced modulator CR205 and CR206. Another output from the square wave generator is applied to square wave amplifier V203 and then to balanced modulator CR207 and CR208. The 100-kc signal is balanced out of the output of each modulator and only the sidebands are present in the output circuits of the two balanced modulators.

b. The upper- and lower-sideband output of balanced modulator CR205 and CR206 is applied to upper-sideband filter Z204. This filter has a passband extending from 100,100 cycles per second (cps) to 106,000 cps, and only the upper-sideband of balanced modulator CR205 and CR206 is permitted to pass through to frequency converter V4201.

c. The upper- and lower-sideband output of balanced modulator CR207 and CR208 is applied to lower-sideband filter Z205. This filter has a passband extending from 94,000 cps to 99,900 cps and only the lower-sideband is permitted to pass through to frequency conveter V4201.

d. Four separate inputs are applied to frequency converter V4201. One input is from upper sideband

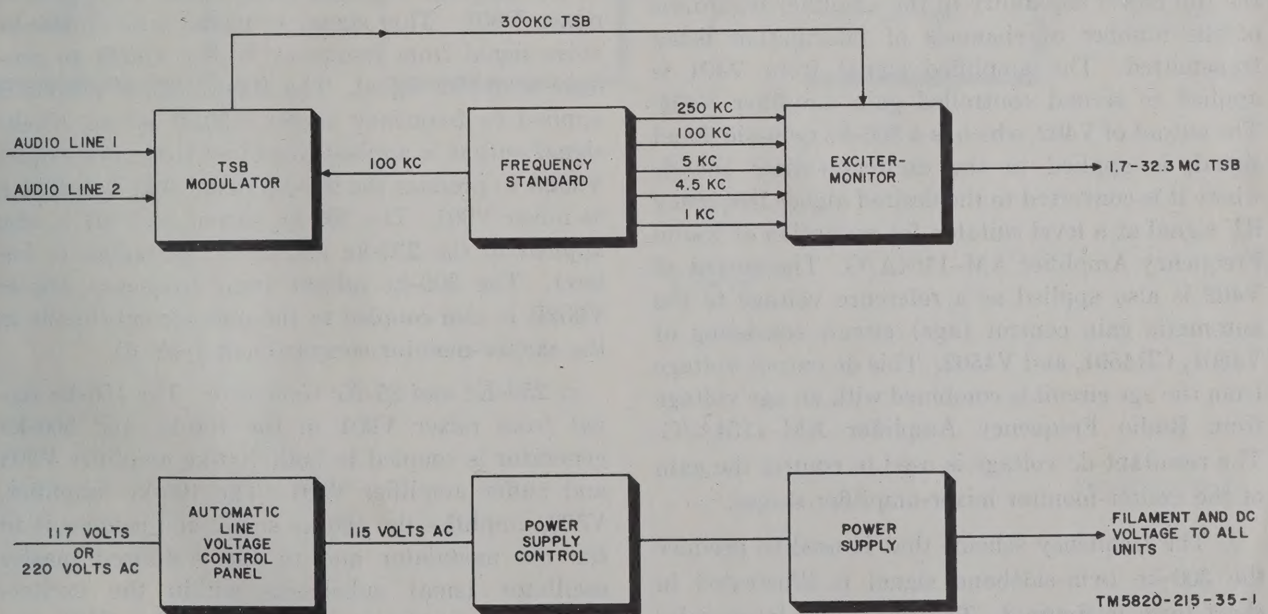


Figure 1. Modulator-oscillator, simplified block diagram.

filter Z204 and another is from lower-sideband filter Z205. A third input is a 100-kc carrier reinsert signal which is applied through carrier attenuation controls AT–4001, AT–4002 and carrier reinsert relay K201. The relay selects either a fixed-level 100-kc carrier signal or the output of carrier attenuation controls AT–4001 and AT–4002. The attenuator control adjusts the reinsertion of any desired amount of carrier in 1-db steps over a range of 50 db. An internal adjustment establishes the reference level for the carrier attenuation control. A separate internal adjustment controls the level of the carrier (fixed-level 100-kc carrier) that is applied to V4201 during the time that the power amplifier (pa) (in Radio Frequency Amplifier AM–1154A/G, TM 11–5821–212–10) is tuning up. A fourth signal is applied from frequency multiplier V4101. This stage accepts a 100-kc signal, multiplies it by 4 and applies the 400-kc signal to frequency converter V4201. Thus there is present in the input of V4201 a range of frequencies from 94 kc to 106 kc and the 400-kc signal from V4101. A 300-kc filter with a 12-kc bandpass permits only signals in the range of 294 through 306 kc to pass through to first controlled-gain amplifier V401.

e. The gain of first and second controlled gain amplifiers V401 and V402 is controlled by a direct current (dc) voltage obtained from the pa stage of Radio Frequency Amplifier AM–1154A/G. The gain of these stages will vary with changes in loading on the pa stage. This circuit permits the use of the full power capability of the amplifier regardless of the number of channels of information being transmitted. The amplified signal from V401 is applied to second controlled gain amplifier V402. The output of V402, which is a 300-kc twin-sideband signal, is applied to the exciter-monitor chassis where it is converted to the desired higher frequency RF signal at a level suitable for excitation of Radio Frequency Amplifier AM–1154A/G. The output of V402 is also applied as a reference voltage to the automatic gain control (agc) circuit consisting of V4501, CR4501, and V4502. This dc output voltage from the agc circuit is combined with an agc voltage from Radio Frequency Amplifier AM–1154A/G. The resultant dc voltage is used to control the gain of the exciter-monitor mixer-amplifier stages.

f. The frequency scheme that is used to produce the 300-kc twin-sideband signal is illustrated in chart form in figure 3. The two audio frequencies are designated as A and B. The subscript numbers of 1 and 2 correspond to the minimum and maximum audiofrequencies accepted by this modulator. For simplicity, only those blocks that produce new frequencies are shown. The sequence used to produce the desired 300-kc twin-sideband signal is described in *a* through *d* above.

5. Frequency Standard

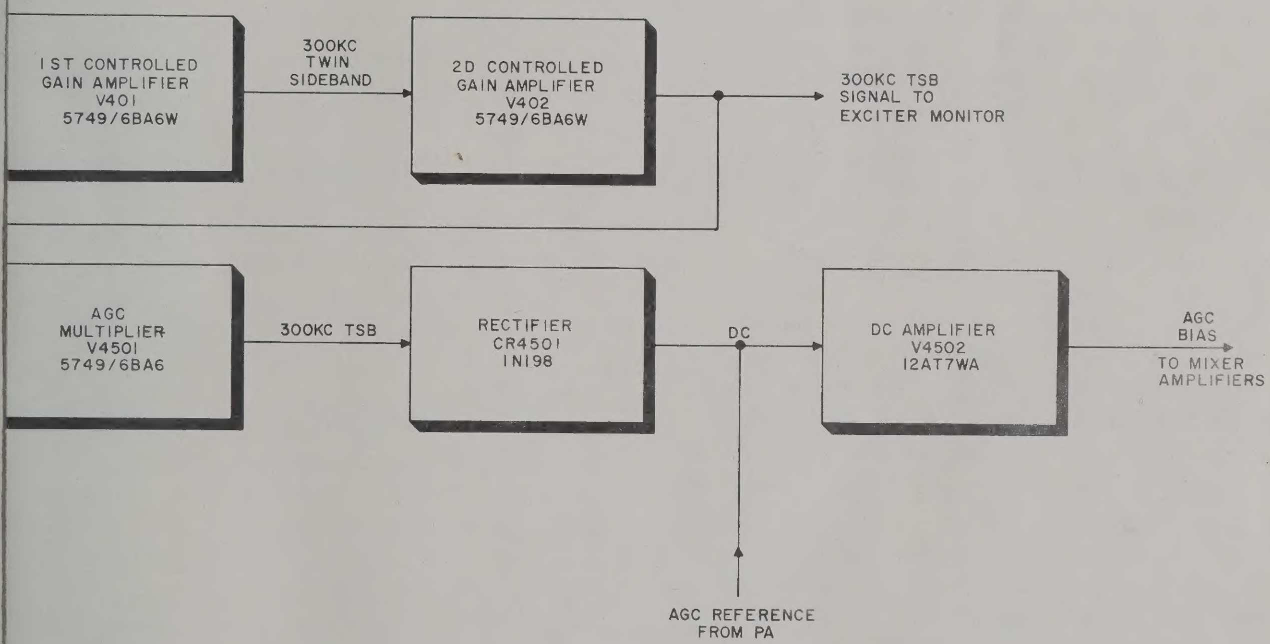
(fig. 4)

The frequency standard unit develops all the basic frequencies used throughout the modulator-oscillator group. All of these frequencies are derived from a crystal-controlled 1-mc oscillator by frequency-divider and mixer-multiplier circuits.

a. Oscillator Subchassis. This subchassis contains the 1-mc crystal oscillator and three stages of RF amplifiers. The frequency standard is developed by 1-mc crystal oscillator V601. The oven in which the frequency-controlling crystal is housed is maintained at a constant temperature (±0.01° C) by an oven-control circuit. Two stages of amplification, V602 and V603, follow the crystal oscillator to amplify the signal and to isolate the crystal oscillator circuit from the frequency divider circuits. One-megacycle output amplifier amplifies and couples the 1-mc signal to mixer V901 in the 100-kc and 300-kc generator.

b. 100-Kc and 300-Kc Generator. This 100-kc and 300-kc generator subchassis accepts a 1-mc signal and uses this signal to produce frequencies of 100 and 300 kc. The 1-mc signal is coupled to mixer V901. This signal is mixed with a 900-kc noise signal from frequency tripler V902A to produce a 100-kc signal. The 100-kc signal output is applied to frequency tripler V902B whose 300-kc signal output is applied to second frequency tripler V902A to produce the 900-kc signal that is fed back to mixer V901. The 100-kc output of V901 is also applied to the 250-kc and 25-kc generator (*c* below). The 300-kc output from frequency tripler V902B is also coupled to the monitor subchassis in the exciter-monitor compartment (par. 6).

c. 250-Kc and 25-Kc Generator. The 100-kc signal from mixer V901 in the 100-kc and 300-kc generator is coupled to both 100-kc amplifier V503 and buffer amplifier V501. The 100-kc amplifier, V503, amplifies the 100-kc signal and couples it to the tsb modulator and to the stabilized master oscillator (smo) subchassis within the exciter-monitor compartment. Buffer amplifier V501 amplifies the 100-kc signal and couples it to mixer-



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filter Z204 and another is from lower-sideband filter Z205. A third input is a 100-kc carrier reinsert signal which is applied through carrier attenuation controls AT–4001, AT–4002 and carrier reinsert relay K201. The relay selects either a fixed-level 100-kc carrier signal or the output of carrier attenuation controls AT–4001 and AT–4002. The attenuator control adjusts the reinsertion of any desired amount of carrier in 1-db steps over a range of 50 db. An internal adjustment establishes the reference level for the carrier attenuation control. A separate internal adjustment controls the level of the carrier (fixed-level 100-kc carrier) that is applied to V4201 during the time that the power amplifier (pa) (in Radio Frequency Amplifier AM–1154A/G, TM 11–5821–212–10) is tuning up. A fourth signal is applied from frequency multiplier V4101. This stage accepts a 100-kc signal, multiplies it by 4 and applies the 400-kc signal to frequency converter V4201. Thus there is present in the input of V4201 a range of frequencies from 94 kc to 106 kc and the 400-kc signal from V4101. A 300-kc filter with a 12-kc bandpass permits only signals in the range of 294 through 306 kc to pass through to first controlled-gain amplifier V401.

e. The gain of first and second controlled gain amplifiers V401 and V402 is controlled by a direct current (dc) voltage obtained from the pa stage of Radio Frequency Amplifier AM–1154A/G. The gain of these stages will vary with changes in loading on the pa stage. This circuit permits the use of the full power capability of the amplifier regardless of the number of channels of information being transmitted. The amplified signal from V401 is applied to second controlled gain amplifier V402. The output of V402, which is a 300-kc twin-sideband signal, is applied to the exciter-monitor chassis where it is converted to the desired higher frequency RF signal at a level suitable for excitation of Radio Frequency Amplifier AM–1154A/G. The output of V402 is also applied as a reference voltage to the automatic gain control (agc) circuit consisting of V4501, CR4501, and V4502. This dc output voltage from the agc circuit is combined with an agc voltage from Radio Frequency Amplifier AM–1154A/G. The resultant dc voltage is used to control the gain of the exciter-monitor mixer-amplifier stages.

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b. 100-Kc and 300-Kc Generator. This 100-kc and 300-kc generator subchassis accepts a 1-mc signal and uses this signal to produce frequencies of 100 and 300 kc. The 1-mc signal is coupled to mixer V901. This signal is mixed with a 900-kc noise signal from frequency tripler V902A to produce a 100-kc signal. The 100-kc signal output is applied to frequency tripler V902B whose 300-kc signal output is applied to second frequency tripler V902A to produce the 900-kc signal that is fed back to mixer V901. The 100-kc output of V901 is also applied to the 250-kc and 25-kc generator (*c* below). The 300-kc output from frequency tripler V902B is also coupled to the monitor subchassis in the exciter-monitor compartment (par. 6).

c. 250-Kc and 25-Kc Generator. The 100-kc signal from mixer V901 in the 100-kc and 300-kc generator is coupled to both 100-kc amplifier V503 and buffer amplifier V501. The 100-kc amplifier, V503, amplifies the 100-kc signal and couples it to the tsb modulator and to the stabilized master oscillator (smo) subchassis within the exciter-monitor compartment. Buffer amplifier V501 amplifies the 100-kc signal and couples it to mixer-

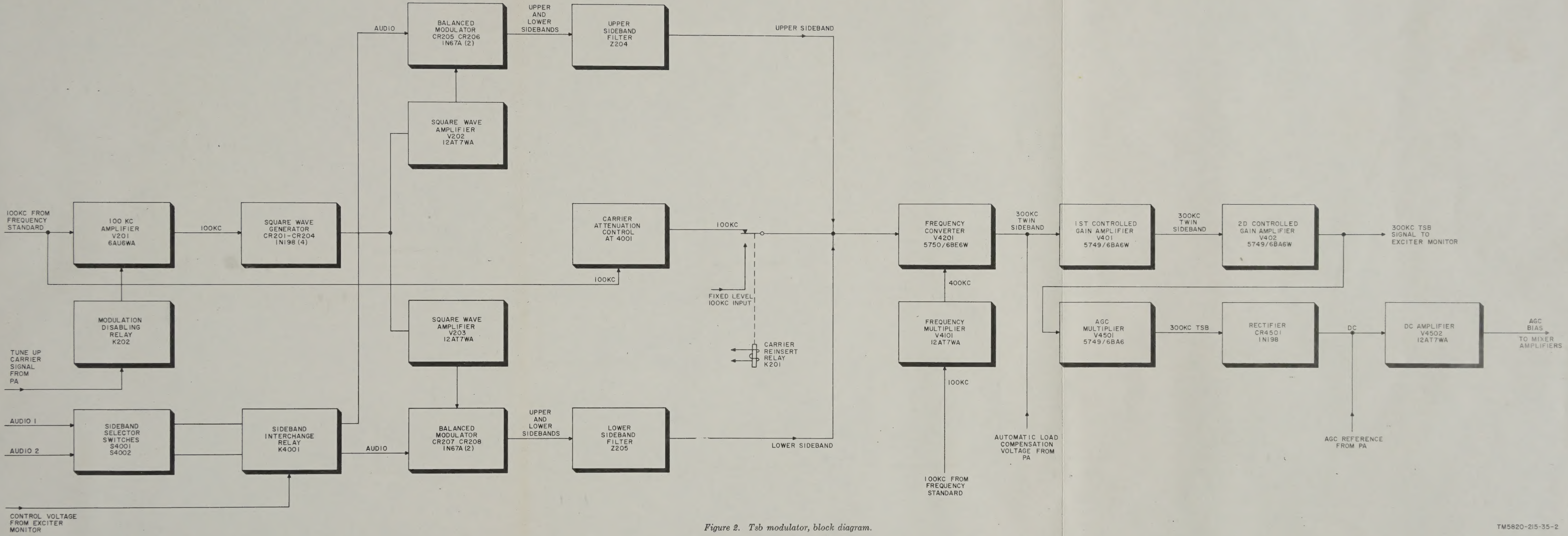

Figure 2. Tsb modulator, block diagram.

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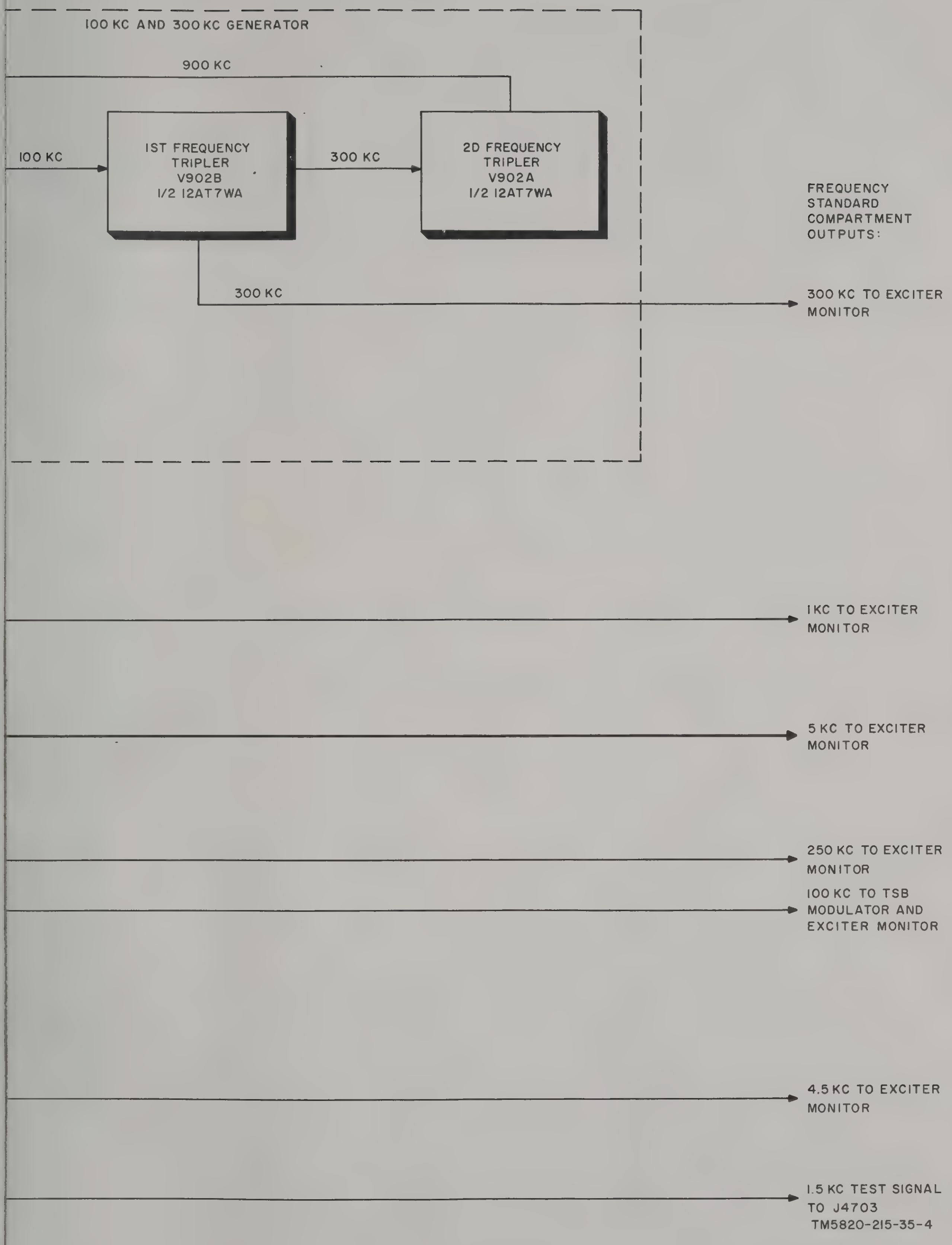

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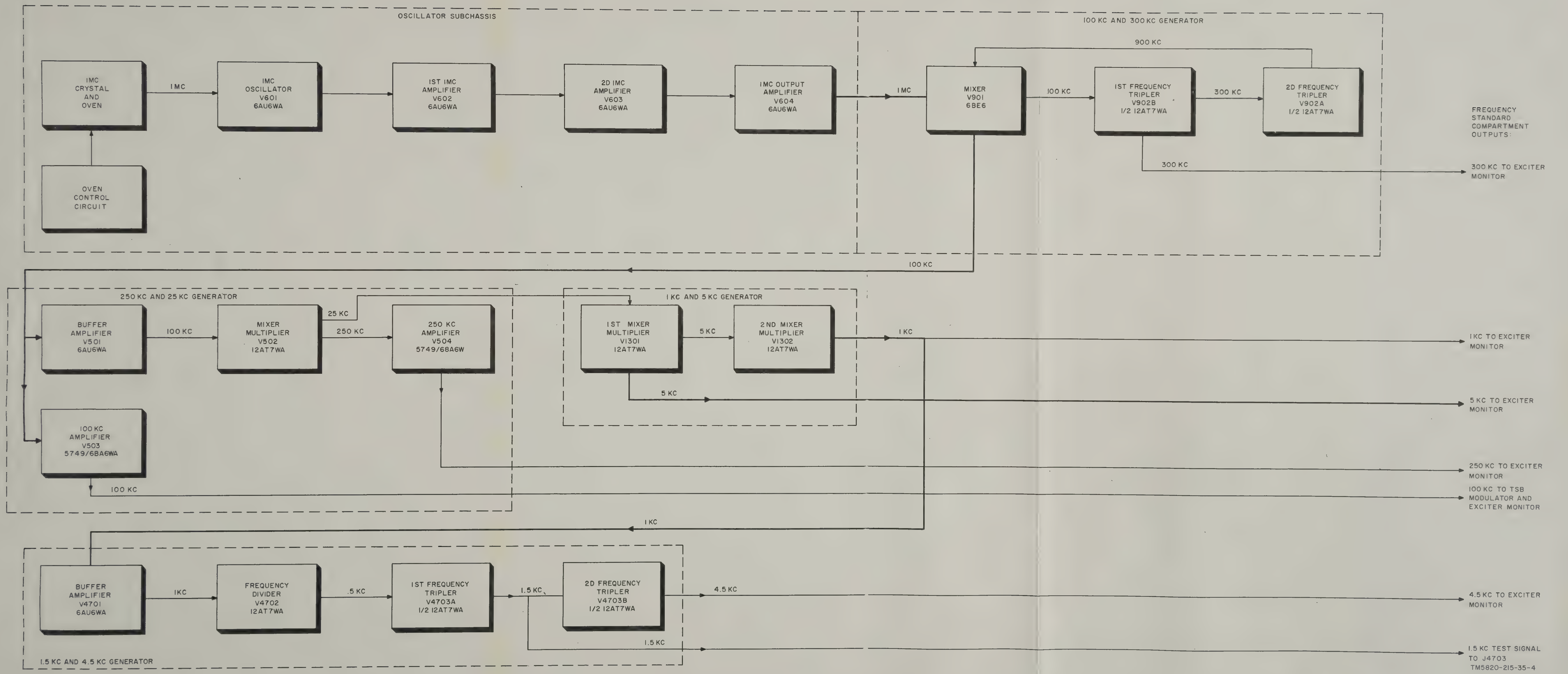


Figure 4. Frequency standard compartment, block diagram.

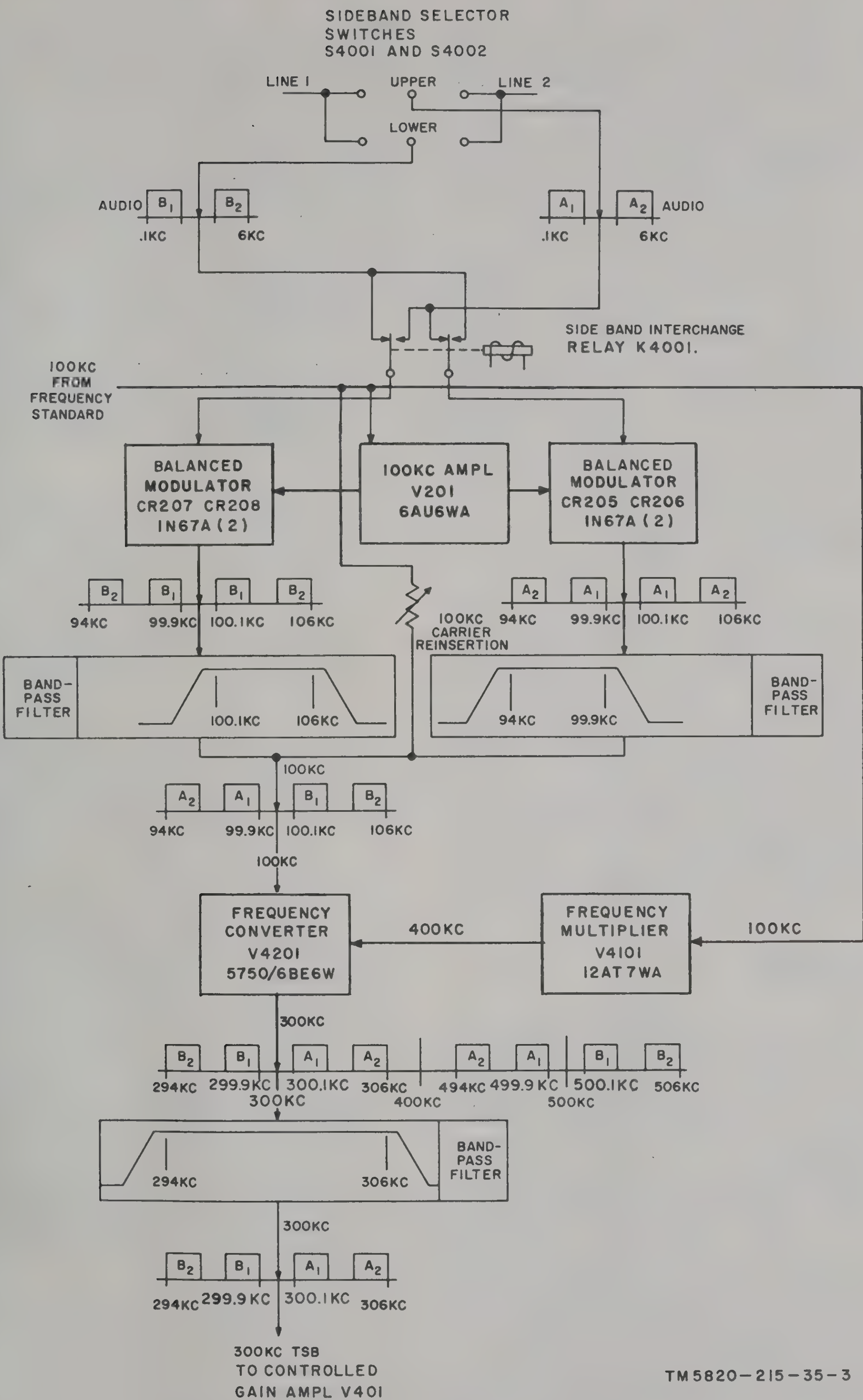


Figure 3. Twin-sideband modulator frequency scheme.

multiplier V502. Mixer-multiplier V502 is a regenerative-mixer circuit that contains both 25-kc and 250-kc signals in the output. The 250-kc signal is amplified by 250-kc amplifier V504 and is applied to the error-detector subchassis within the exciter-monitor compartment. The 25-kc output of V502 is applied to the 1-kc and 5-kc generator subchassis.

d. 1-Kc and 5-Kc Generator. The 1-kc and 5-kc generator subchassis contains two similar *divide by 5* stages that divide the input frequency of 25 kc to 1 kc. The input signal is applied to first mixer-multiplier V1301. This stage divides the input signal by five and applies a 5-kc signal to the 0.5-kc spectrum detent subchassis in the exciter-monitor unit. The 5-kc signal is also applied to another *divide by 5* stage, second mixer-multiplier V1302, whose 1-kc output is also applied to the 0.5-kc spectrum detent subchassis within the exciter-monitor and to buffer amplifier V4701 in the 1.5-kc and 4.5-kc generator subchassis.

e. 1.5-Kc and 4.5-Kc Generator. The 1-kc signal from V1302 in the 1-kc and 5-kc generator is applied to buffer amplifier V4701 which amplifies and couples the signal to a *divide by 2* stage, frequency divider V4702. The 0.5-kc output signal from V4702 is applied to two frequency tripler stages connected in cascade. The 1.5-kc output of first frequency tripler V4703A is applied to second frequency tripler V4703B. The 4.5-kc output of the second tripler is applied to the 0.5-kc spectrum detent subchassis in the exciter-monitor compartment. The 1.5-kc output of V4703A is coupled through J4703 and is used for test purposes.

6. Exciter-Monitor

(fig. 5)

The exciter-monitor compartment contains five mixer-amplifier subchassis, frequency generating and conversion circuits, and a variable stabilized master oscillator with circuits for oscillator stabilization. The mixer-amplifiers heterodyne the twin-sideband signal from the tsb modulator, with conversion signals from the stabilized master oscillator to produce an output signal at any selected frequency between 1.7 mc and 30 mc. The frequency range of the equipment is divided into five bands that are selected by a band switch. The smo supplies a 2-mc to 4-mc conversion signal, and the multiplier circuits supply 6-mc to 12-mc and 14-mc to 28-mc conversion signals to the mixer-amplifiers. These frequencies are stabilized by frequency and phase control of the smo. A frequency-control voltage, developed as a result of comparing the frequency originating in this oscillator with a frequency derived from the extremely stable 1-mc crystal oscillator (par. 5*a*), controls the plate current of a control tube. Change in plate current varies the inductance of a saturable reactor in the smo tuning circuit and corrects for any frequency error.

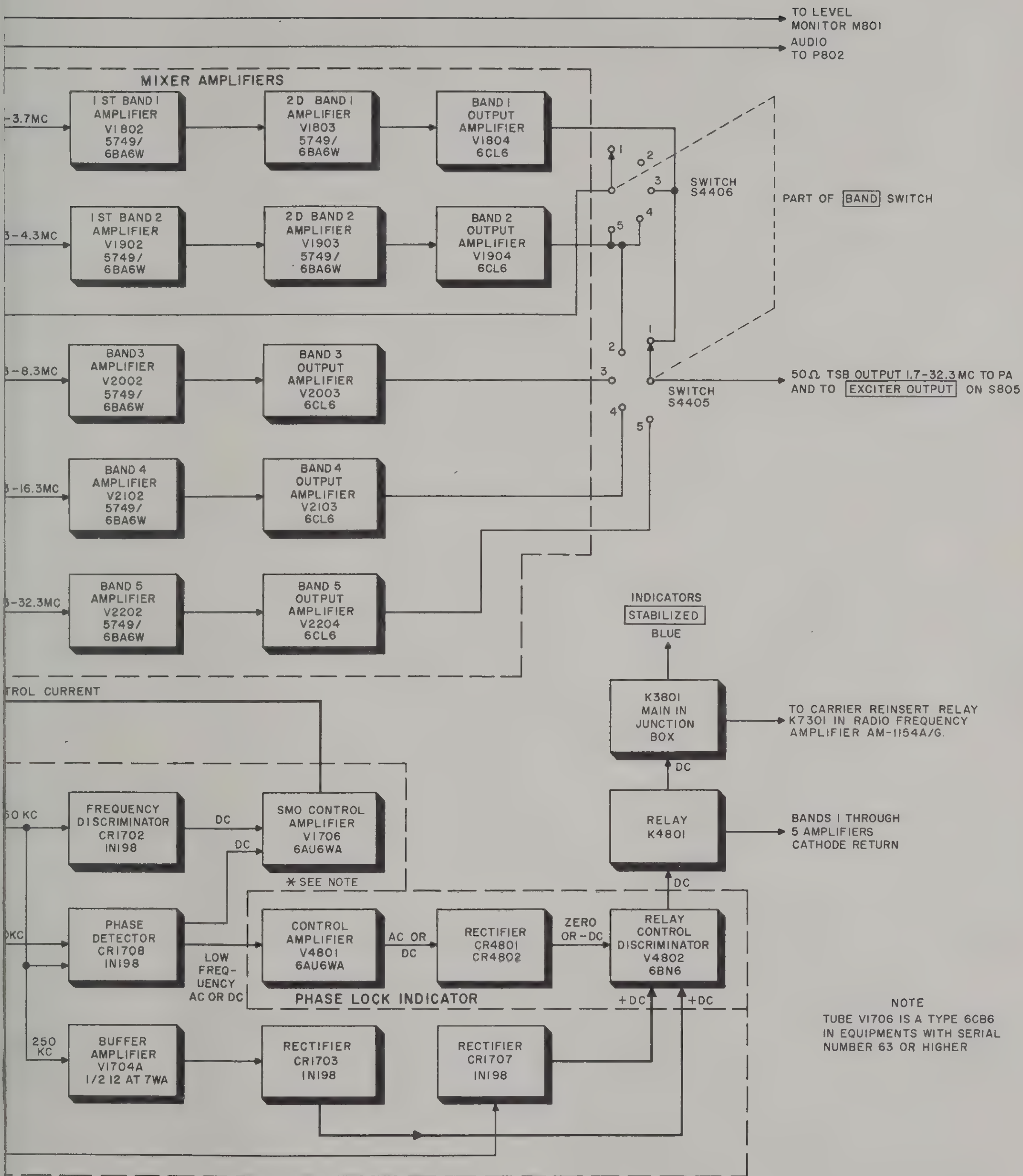
a. Mixer-Amplifiers (fig. 5).

(1) The 300-kc tsb signal from the tsb modulator is applied to one of five mixer amplifier inputs, depending on the frequency of transmission selected. The five mixer-amplifier stages cover the following frequencies:

Band	Frequencies (mc)
1	1.7 to 3.7
2	2.3 to 4.3
3	4.3 to 8.3
4	8.3 to 16.3
5	16.3 to 32.3

(2) Assume that an output frequency of 2,000 kc is desired. The 300-kc tsb signal is applied directly to band 1 mixer V1801. The smo applies a frequency of 2,300 kc to the same mixer tube. The two signal frequencies mix and produce a difference frequency tsb signal at 2,000 kc that is amplified by band 1 amplifiers V1802 through V1804 and applied to Radio Frequency Amplifier AM–1154A/G for further amplification and transmission. Note that only one mixer-amplifier section, V1801 through V1804, was used to produce the desired output. If a frequency is selected that is within the frequency range of band 2, the operation is similar, except that the output of the band 2 mixer-amplifier is the *sum* of the 300-kc tsb signal and the fundamental frequencies of the smo ((4) below).

(3) When a signal is selected that is within the band 3 group of frequencies, the operation is somewhat different. Assume that an output frequency of 5,300 kc is selected. The 300-kc tsb signal is applied to mixer



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multiplier V502. Mixer-multiplier V502 is a regenerative-mixer circuit that contains both 25-kc and 250-kc signals in the output. The 250-kc signal is amplified by 250-kc amplifier V504 and is applied to the error-detector subchassis within the exciter-monitor compartment. The 25-kc output of V502 is applied to the 1-kc and 5-kc generator subchassis.

d. 1-Kc and 5-Kc Generator. The 1-kc and 5-kc generator subchassis contains two similar *divide by 5* stages that divide the input frequency of 25 kc to 1 kc. The input signal is applied to first mixer-multiplier V1301. This stage divides the input signal by five and applies a 5-kc signal to the 0.5-kc spectrum detent subchassis in the exciter-monitor unit. The 5-kc signal is also applied to another *divide by 5* stage, second mixer-multiplier V1302, whose 1-kc output is also applied to the 0.5-kc spectrum detent subchassis within the exciter-monitor and to buffer amplifier V4701 in the 1.5-kc and 4.5-kc generator subchassis.

e. 1.5-Kc and 4.5-Kc Generator. The 1-kc signal from V1302 in the 1-kc and 5-kc generator is applied to buffer amplifier V4701 which amplifies and couples the signal to a *divide by 2* stage, frequency divider V4702. The 0.5-kc output signal from V4702 is applied to two frequency tripler stages connected in cascade. The 1.5-kc output of first frequency tripler V4703A is applied to second frequency tripler V4703B. The 4.5-kc output of the second tripler is applied to the 0.5-kc spectrum detent subchassis in the exciter-monitor compartment. The 1.5-kc output of V4703A is coupled through J4703 and is used for test purposes.

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(2) Assume that an output frequency of 2,000 kc is desired. The 300-kc tsb signal is applied directly to band 1 mixer V1801. The smo applies a frequency of 2,300 kc to the same mixer tube. The two signal frequencies mix and produce a difference frequency tsb signal at 2,000 kc that is amplified by band 1 amplifiers V1802 through V1804 and applied to Radio Frequency Amplifier AM–1154A/G for further amplification and transmission. Note that only one mixer-amplifier section, V1801 through V1804, was used to produce the desired output. If a frequency is selected that is within the frequency range of band 2, the operation is similar, except that the output of the band 2 mixer-amplifier is the *sum* of the 300-kc tsb signal and the fundamental frequencies of the smo ((4) below).

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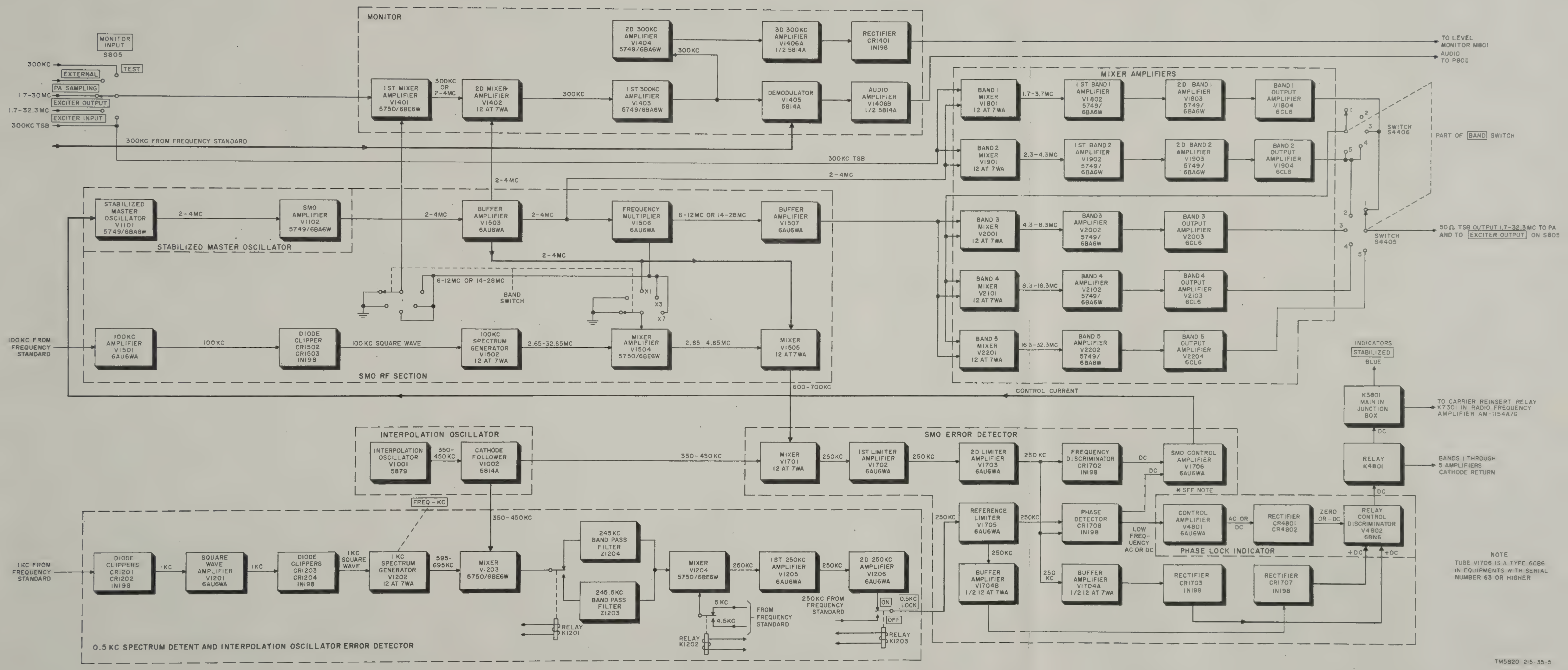

Figure 5. Exciter-monitor, block diagram.

V1801 ((2) above), where it is mixed with a 2,500-kc signal from the smo. The difference frequency of 2,200 kc is amplified by amplifiers V1802 through V1804 and applied to band 3 mixer V2001. The third harmonic of the smo frequency, 7,500 kc (3 times 2,500 kc), is applied to mixer V2001. The output of V2001, 5,300 kc (7,500 kc minus 2,200 kc), is amplified by band 3 amplifiers V2002 and V2003 and is available for application to Radio Frequency Amplifier AM–1154A/G for further amplification and transmission.

(4) The frequency scheme for all the frequencies used in the exciter-monitor is shown in the chart below. Note that all bands, except bands 1 and 2, employ a double conversion system where, at the first conversion stage, the fundamental frequency of the smo is mixed with the 300-kc tsb signal and, at the second conversion stage, the desired harmonic of the smo output is mixed with the output of the first mixer. On bands 1 and 3, the *difference frequency* is used and on bands 2, 4, and 5 the *sum frequency* is used.

output of the smo is applied to one of the RF mixer amplifier circuits (*a* above) to produce the desired output frequency. A keyed-oscillator circuit, functioning as a spectrum generator, is tuned simultaneously with the smo. The output of this spectrum generator is mixed with a portion of the smo output and applied to the error-detector subchassis. Two error voltages produced in the error-detector subchassis affect a control current that is used to correct the error in the smo.

(1) Stabilized master oscillator V1101 operates in the frequency range of 2 to 4 mc. Its frequency of operation is set by the FREQ-MC and FREQ-KC controls. These controls vary the inductance in the oscillator tank circuit. A control current from the smo error-detector subchassis corrects for any minor frequency error.

(2) The output of V1101 is coupled to smo amplifier V1102. Both V1101 and V1102 are contained in a shielded subchassis. The output of the smo subchassis is coupled to buffer amplifier V1503.

(3) Buffer amplifier V1503 isolates the smo from the effects of external loading. When the frequency of operation is within the range of band 1 (1.7 to 3.7 mc) or band 2 (2.3 to 4.3 mc), the oscillator output is applied directly from the buffer amplifier to the band 1 or band 2 RF mixer amplifier.

Band	1.7 mc to 3.7 mc mixer-amplifier 1		2.3 mc to 4.3 mc mixer-amplifier 2		4.3 mc to 8.3 mc mixer-amplifier 3		8.3 mc to 16.3 mc mixer-amplifier 4		16.3 mc to 32.3 mc mixer-amplifier 5	
	Conversion freq mc	Output freq mc	Conversion freq mc	Output freq mc	Conversion freq mc	Output freq mc	Conversion freq mc	Output freq mc	Conversion freq mc	Output freq mc
1. Lowest frequency	2.0	1.7								
Highest frequency	4.0	3.7								
2. Lowest frequency			2.0	2.3						
Highest frequency			4.0	4.3						
3. Lowest frequency	2.0	1.7	→	→	6.0	4.3				
Highest frequency	4.0	3.7	→	→	12.0	8.3				
4. Lowest frequency			2.0	2.3	→	→	6.0	8.3		
Highest frequency			4.0	4.3	→	→	12.0	16.3		
5. Lowest frequency			2.0	2.3	→	→	→	→	14	16.3
Highest frequency			4.0	4.3	→	→	→	→	28	32.3

Note: Tsb input is always 300 kc.

b. Stabilized Master Oscillator (fig. 5). The smo chassis contains a permeability-tuned oscillator that is *locked* to the extremely stable frequency standard. Multiplier circuits within the smo chassis extend the 2–4-mc range of the smo to 28 mc. The

(4) When operation on band 3, 4, or 5 is desired, the smo output is applied through V1503 to frequency multiplier V1506. Tube V1506 operates as a frequency tripler on bands 3 and 4. To produce the band 5 range of frequencies (6.3 to 32.3 mc), V1506 multiplies the smo frequencies by 7. This is illustrated in the frequency chart shown in *a*(4) above.

(5) A 100-kc signal from the frequency standard compartment is applied to 100-kc amplifier V1501. The output of V1501 is clipped by crystal diodes CR1502 and CR1503 to produce a square wave at 100 kc that is rich in harmonic content. The square wave is applied to 100-kc spectrum generator V1502.

(6) The 100-kc spectrum generator, V1502, is keyed by the square wave output of CR1502 and CR1503. The selected frequency at the output of V1502 is determined by the components that are switched into the plate circuit. This frequency can be varied from 2.65 mc to 32.65 mc in integral multiples of 100 kc. The output of V1502 is applied to mixer-amplifier V1504 which operates as an amplifier on bands 1 and 2 and as a mixer on bands 3, 4, and 5.

(7) Assume that 1,700 kc is selected as the output frequency. The following frequency mixing results:

(*a*) The smo produces 2,000 kc.

(*b*) The 300-kc tsb signal mixes with the 2,000-kc signal and a 1,700-kc signal is available at the band 1 output amplifier, V1804.

(*c*) The 100-kc spectrum generator, V1502, produces 2,700 kc. The output of V1502 is applied to mixer amplifier V1504, which operates as an amplifier at this frequency. The output of V1504 is applied to mixer V1505.

(*d*) Mixer V1505 receives the 2,700-kc signal from V1504 and the 2,000-kc signal from the smo. A difference frequency of 700 kc is coupled to the smo error-detector subchassis. The signal (together with another signal produced in the smo error detector) is used to influence the smo control current that maintains the master oscillator on frequency. The smo error detector is covered in *c* below.

(8) Mixer-amplifier V1504 functions as a mixer on bands 3 through 5. To understand the operation of these bands, assume that a final carrier frequency of 16,300 kc is desired from the exciter-monitor. The following actions take place:

(*a*) The 100-kc spectrum generator V1502 produces a frequency of 16,700 kc.

(*b*) This 16,700-kc signal is applied to mixer-amplifier V1504 where it is mixed with the seventh harmonic of the smo frequency (14,000 kc in this example).

(*c*) The difference frequency of 2,700 kc is applied to mixer V1505. Also applied to this mixer is the smo frequency of 2,000 kc. The difference frequency of 700 kc is coupled to the error-detector subchassis.

(9) Regardless of the exciter-monitor output carrier frequency selected, the output of mixer V1505 will always be between 600 and 700 kc.

c. Interpolation Oscillator and Smo Error Detector (fig. 5). The smo error-detector chassis compares the frequency (within 600-kc to 700-kc range) from the smo RF section with the output of variable (350-450 kc) interpolation oscillator V1001. Mixer V1701 heterodynes these two signals and produces a 250-kc signal that is applied to a frequency discriminator and a phase detector within the smo error-detector subchassis. The output of the smo error detector reduces the error in the smo frequency.

(1) The frequency of interpolation oscillator V1001 is controlled by the setting of the FREQ-KC dial. The oscillator frequency can be varied 100 kc (from 350 to 450 kc). The tank circuit of the interpolation oscillator is mechanically linked with the smo tank circuit, thereby maintaining a fixed-frequency difference of 250 kc between the output of the interpolation oscillator and the output of mixer V1505 in the smo RF section chassis (*b* above). The output of interpolation oscillator V1001 is coupled to cathode follower V1002. Cathode follower V1002 isolates the interpolation oscillator from the loading of the error-detector mixers and couples a signal (be-

tween 350 kc and 450 kc) to the smo error detector. The interpolation oscillator signal is also coupled to the 0.5-kc spectrum detent subchassis. This subchassis develops an output frequency that contains the interpolation error (if an error exists) that is applied to phase detector CR1708 for cancellation.

(2) Mixer V1701 heterodynes the signal from the smo RF section (600 to 700 kc) with the 350- to 450-kc signal from V1002 in the interpolation oscillator; this produces a 250-kc signal that contains the frequency errors of stabilized master oscillator V1101 and interpolation oscillator V1001.

(3) The 250-kc output of mixer V1701 is coupled to a two-stage cascaded limiter, V1702 and V1703. The purpose of the limiter stages is to provide a constant-amplitude signal to the frequency discriminator and phase detector.

(4) The frequency discriminator receives the constant-amplitude 250-kc signal and produces a dc output voltage that is indicative of the direction and amount of frequency error. This voltage is applied to the control grid (in series with another correction voltage from the 0.5-kc spectrum detent) of smo control amplifier V1706. The plate current of V1706 controls the frequency of the smo.

(5) Note that the frequency correction, described in (4) above, did not compensate for any errors that could result from a frequency error in the interpolation oscillator. Unless this error is compensated, a frequency drift in the interpolation oscillator could result in an undesired correction being applied to the smo. The output of the 0.5-kc spectrum detent subchassis (described in *d* below) is a 250-kc signal, plus or minus the interpolation oscillator error. This signal is used in the smo error detector to compensate for frequency errors in the interpolation oscillator. It is also applied to phase detector CR1708 through reference limiter V1705.

(6) Phase detector CR1708 compares the 250-kc reference signal from the 0.5-kc spectrum-subchassis circuit with the 250-kc signal from second limiter amplifier V1703. The output of the phase detector is a voltage indicative of the amount and direction of error in the interpolation oscillator frequency. The dc correction voltage from frequency discriminator CR1702 and the correction voltage from phase detector CR1708 are applied in series to smo control amplifier V1706. The change in V1706 plate current, caused by the correction voltage, corrects for the any frequency errors caused by the smo.

(7) The 250-kc signal from reference limiter V1705 is also coupled to buffer amplifier V1704B. The output of V1704B is rectified by rectifier CR1707 and applied to the phase lock indicator subchassis (*e* below). The 250-kc signal from second limiter amplifier V1703 is coupled to buffer amplifier V1704A. The output of V1704A is rectified by rectifier CR1703 and also applied to the phase lock indicator subchassis.

d. 0.5-Kc Spectrum Detent Subchassis (fig. 5). This subchassis mixes the 350-kc to 450-kc signal from interpolation oscillator V1001 with the spectrum output of a keyed oscillator whose frequency is accurately controlled at integral multiples of 1 kc. The output of this subchassis is applied to reference limiter V1705 in the smo error detector subchassies where a phase detector produces a voltage that is indicative of the amount and direction of frequency error existing in the interpolation oscillator.

(1) A 1-kc signal from the frequency standard compartment is applied to diode clippers CR1201 and CR1202. The clipped signal is applied to square wave amplifier V1201 whose output is again clipped by diode clippers CR1203 and CR1204. The square wave output of this clipper circuit is rich in harmonic content and is used to trigger 1-kc spectrum generator V1202.

(2) The output of 1-kc spectrum generator V1202 is a group of frequencies tunable by the FREQ-KC control through a frequency range of 595 kc to 695 kc at integral multiples of 1 kc. Mixer V1203 heterodynes the output of V1202 with the signal from the interpolation oscillator (350 kc to 450 kc). The resultant fre-

quency is a 245-kc reference signal when the FREQ-KC dial is set to even 0.5-kc points, and a 245.5-kc reference signal when the FREQ-KC dial is set to odd 0.5-kc points.

(3) The output of mixer V1203 is applied across the input of the two mechanical 500-cps band pass filters (Z1203 centered at 245.5 kc and Z1204 centered at 245 kc). When the FREQ-KC control is set to an even 0.5-kc point, relays K1201 and K1202 are deenergized. In the deenergized condition, relay K1201 connects 245-kc band pass filter Z1204 into the circuit. Two signals, 4.5 kc and 5 kc, both derived from the frequency standard compartment, are available for mixing with the output of the selected band pass filter. Because relay K1202 is deenergized, the 5-kc signal is coupled to mixer V1204 where it is heterodyned with the 245-kc signal to produce the desired 250-kc signal.

(4) When the FREQ-KC control is set to an ood 0.5-kc point, relays K1201 and K1202 are energized. Relay K1201 connects Z1203 into the circuit and relay K1202 connects the 4.5-kc signal from the frequency standard to mixer V1204. The 245.5-kc signal from Z1203 mixes with the 4.5-kc signal to produce the 250-kc reference signal.

(5) The 250-kc reference signal from V1204 is applied to the cascaded first and second 250-kc amplifiers, V1205 and V1206. The output of V1206 is applied through the closed contacts of deenergized relay K1203 to reference limiter V1705 in the smo error detector when the 0.5 KC LOCK switch is set to ON.

(6) When the 0.5 KC LOCK switch is set to OFF, the output of the 0.5-kc spectrum detent circuit is removed from the circuit and a 250-kc signal from the frequency standard is applied through the contacts of relay K1203 to reference limiter V1705 in the smo error detector. The 250-kc reference signal is secured from the frequency standard and continuous tuning of the exciter-monitor is possible. However, greater accuracy is possible when the 250-kc reference signal is obtained from the 0.5-kc spectrum detent circuit.

e. Exciter-Monitor Frequency Schemes.

(1) The frequency scheme of the exciter-monitor compartment when the 0.5 KC LOCK switch is set to ON is shown in figure 6. For simplicity, stages that do not contribute to frequency changes have been omitted. The two sideband inputs to the exciter-monitor are labelled A and B, with subscript numbers 1 and 2 denoting the minimum and maximum frequencies within a particular sideband.

(2) Figure 7 is the frequency scheme when an output frequency of 1,750 kc is desired and the 0.5 KC LOCK switch is set to OFF. There is one major difference that exists between the frequency schemes shown in figures 6 and 7. In figure 6, the output of the 0.5-kc spectrum detent is applied to the phase detector stage in the smo error detector chassis to correct for any error that may have been introduced by the interpolation oscillator. In figure 7, the interpolation oscillator error is not corrected. Therefore, for maximum frequency stability, the 0.5 KC LOCK switch should be set to ON.

(3) In the frequency scheme examples (figs. 6 and 7), only a single frequency conversion is used to obtain an output frequency from the mixer-amplifier section of the exciter-monitor. When an output frequency above that of band 2 is selected, a double conversion system is used (*a*(3) above). Figure 8 illustrates the frequency scheme when an output frequency of 16.300 mc is desired from the exciter-monitor. Note that the output of the band 2 mixer-amplifier is applied to band 5 mixer V2201 where it is mixed with a 14.000-mc signal from V1506. Frequency multiplier V1506 multiplies the 2.000- mc signal from the smo by 7. The output of the band 5 mixer-amplifier is the sum of the 2.300-mc signal from the band 2 mixer-amplifier and the 14.000-mc signal from frequency multiplier V1506.

f. Phase Lock Indicator (fig. 5). The phase lock indicator circuit prevents any output from the

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(5) The 250-kc reference signal from V1204 is applied to the cascaded first and second 250-kc amplifiers, V1205 and V1206. The output of V1206 is applied through the closed contacts of deenergized relay K1203 to reference limiter V1705 in the smo error detector when the 0.5 KC LOCK switch is set to ON.

(6) When the 0.5 KC LOCK switch is set to OFF, the output of the 0.5-kc spectrum detent circuit is removed from the circuit and a 250-kc signal from the frequency standard is applied through the contacts of relay K1203 to reference limiter V1705 in the smo error detector. The 250-kc reference signal is secured from the frequency standard and continuous tuning of the exciter-monitor is possible. However, greater accuracy is possible when the 250-kc reference signal is obtained from the 0.5-kc spectrum detent circuit.

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f. Phase Lock Indicator (fig. 5). The phase lock indicator circuit prevents any output from the

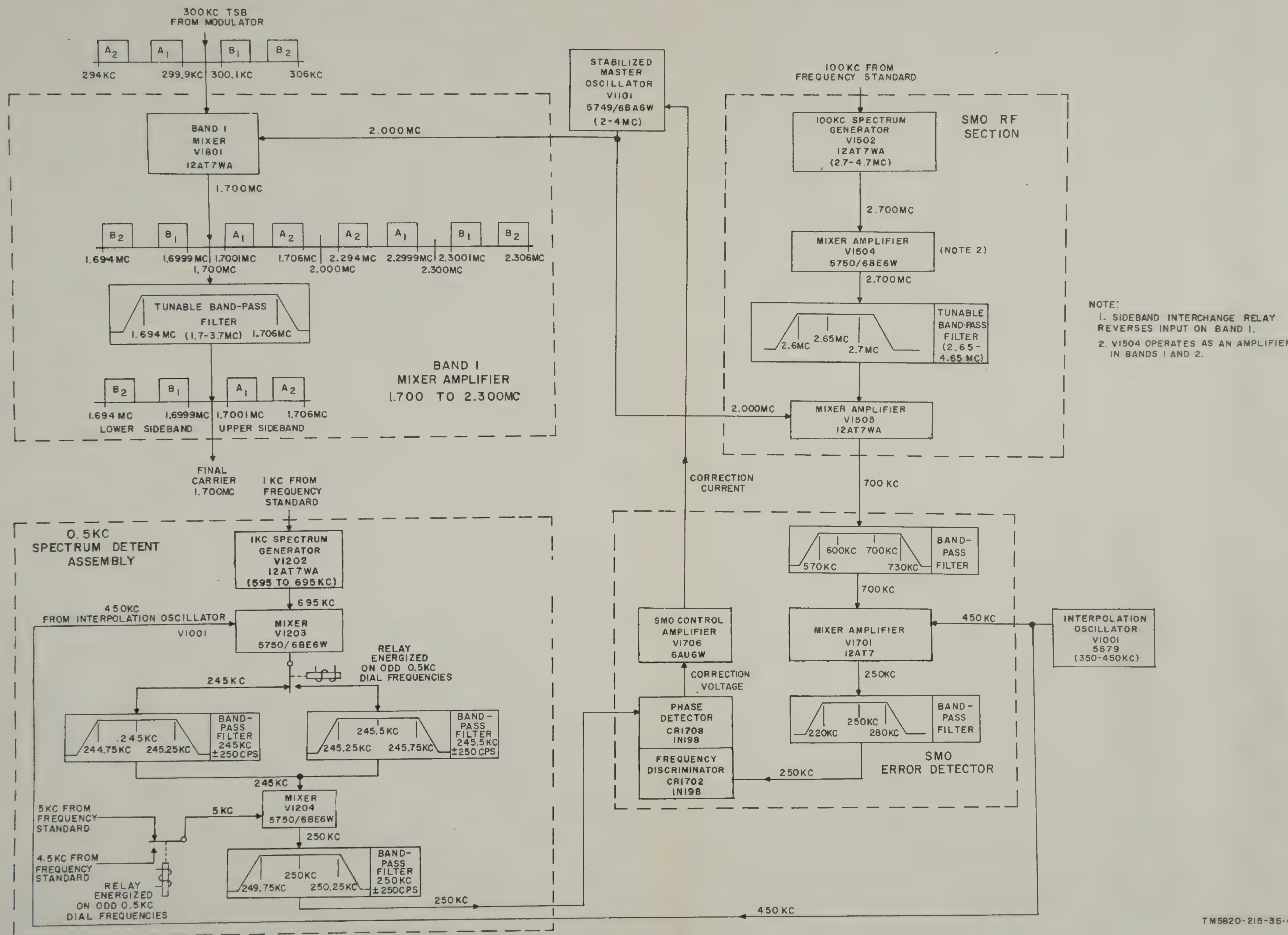


Figure 6. Exciter-monitor frequency scheme, band 1, dial setting 1.7000 mc, 0.5 KC LOCK switch ON.

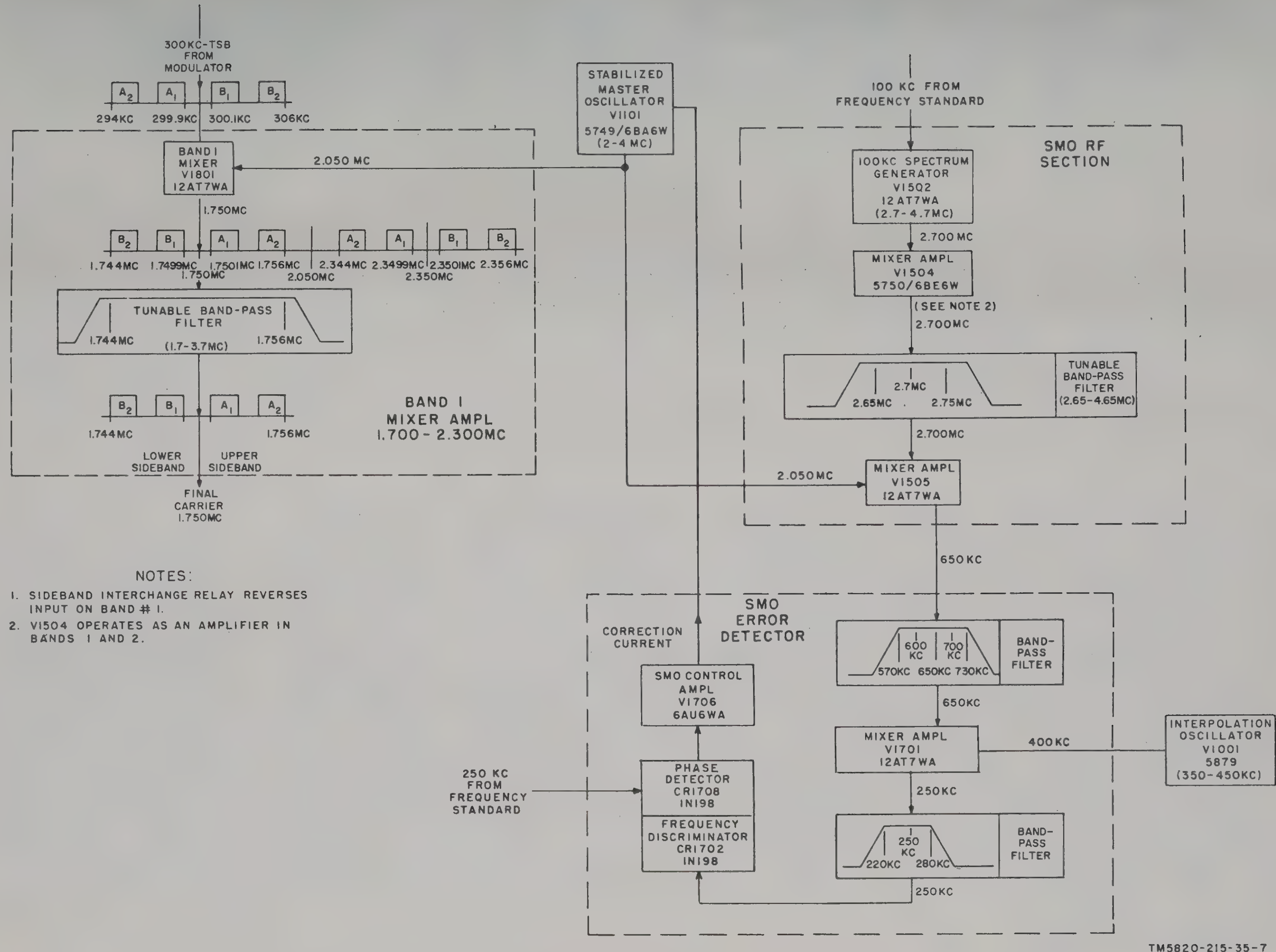


Figure 7. Exciter-monitor frequency scheme, band 1, dial setting 1.7500 mc, 0.5 KC LOCK switch OFF.

modulator-oscillator group until the stabilized master oscillator is correctly tuned. Relays associated with this circuit complete the B+ path to the mixer-amplifiers and complete the circuit to a STABILIZED indicator light on the power control panel. The control circuit of the phase lock indicator subchassis uses a gated-beam 6BN6 type tube (V4802). The plate current of V4802 controls the operation of relays K3801 and K4801. The operation of V4802 and the two relays depends upon the following three control voltages:

(1) One voltage is derived from the 0.5-kc spectrum detent section. This voltage is coupled to rectifier CR1707 through reference limiter V1705 and buffer amplifier V1704B. The output of CR1707 is applied as a positive dc voltage to V4802.

(2) A second control voltage is obtained from second limiter amplifier V1703 in the smo error detector section. This voltage is coupled through buffer amplifier V1704A and rectified by rectifier CR1703. This positive dc voltage is also applied to V4802.

(3) When the phase detector input frequency and phase detector reference frequency are not alike, phase detector CR1708 produces an ac output voltage which is applied to control amplifier V4801. This stage amplifies the alternating current (ac) voltage and applies it to rectifier circuit CR4801 and CR4802. The output of these rectifiers is a negative voltage which cuts off V4802.

(4) Tube V4802 energizes relays K3801 and K4801 when the voltages described in (1) and (2) above are present and the voltage described in (3) does not exist. Any change in these conditions will deenergize relays K3801 and K4801.

g. Monitor Chassis (fig. 5).

(1) The monitor chassis contains six stages of mixers and amplifiers. By operating the MONITOR INPUT selector switch, a signal from any of the following points can be applied to the monitor input:

(*a*) EXCITER INPUT (300 kc tsb).

(*b*) EXCITER OUTPUT (1.7—32.3 mc).

(*c*) PA SAMPLING (1.7—30 mc).

(*d*) EXTERNAL pickup (50-ohm input from EXTERNAL PICKUP jack on front panel of exciter-monitor).

(*e*) TEST (300-kc sine wave signal from frequency standard).

(2) The output of the monitor is displayed on the front panel meter of the exciter-monitor when the METER SWITCH is placed in position 1 (MONITOR SIGNAL LEVEL). The audio output of the monitor is also made available through terminals 31 and 32 of P802 in the exciter-monitor.

(3) When the monitor is used to receive signals in the band 1 or band 2 range, the following actions take place:

(*a*) Assume that a signal of 1,700 kc is to be monitored (fig. 9). This 1,700-kc signal is applied to first mixer-amplifier V1401. At this frequency, this stage functions as an ordinary RF amplifier whose output is applied to second mixer-amplifier V1402.

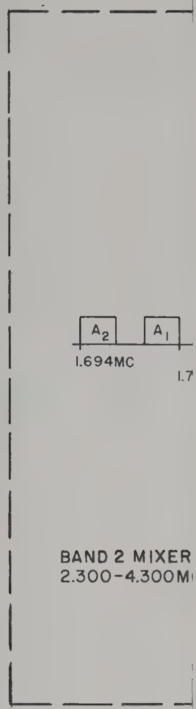
(*b*) Tube V1402 mixes the 1,700-kc signal with a 2,000-kc frequency from the smo and a resulting 300-kc signal is applied to first 300-kc amplifier V1403.

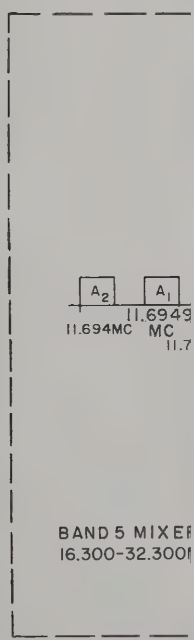
(*c*) The output from V1403 is coupled through cascaded second and third 300-kc amplifiers V1404 and V1406A, deetected by rectifier CR1401, and applied to meter M801 (METER SWITCH in position 1).

(*d*) The output from V1403 is also applied to demodulator V1405. Here it is mixed with a 300-kc signal from the frequency standard compartment.

(*e*) The 300-kc signal from V1403 mixes with the 300-kc signal from the frequency standard. The difference frequency (audio) is applied to V1406B. The audio output of this stage is made available at terminals 31 and 32 of P802 in the exciter-monitor chassis. Note that this audio output is intelligible only if a single-sideband transmission is monitored. Normally, this facility is used for test purposes rather than for aural monitoring.

(4) When the monitor circuit is used to receive signals in the bands 3 through 5 range, the following actions take place:


A2
A1
1.694MC
1.7
BAND 2 MIXER
2.300-4.300M


A2
A1
11.6949
11.694MC
MC
11.7
BAND 5 MIXER
16.300-32.300

modulator-oscillator group until the stabilized master oscillator is correctly tuned. Relays associated with this circuit complete the B+ path to the mixer-amplifiers and complete the circuit to a STABILIZED indicator light on the power control panel. The control circuit of the phase lock indicator subchassis uses a gated-beam 6BN6 type tube (V4802). The plate current of V4802 controls the operation of relays K3801 and K4801. The operation of V4802 and the two relays depends upon the following three control voltages:

(1) One voltage is derived from the 0.5-kc spectrum detent section. This voltage is coupled to rectifier CR1707 through reference limiter V1705 and buffer amplifier V1704B. The output of CR1707 is applied as a positive dc voltage to V4802.

(2) A second control voltage is obtained from second limiter amplifier V1703 in the smo error detector section. This voltage is coupled through buffer amplifier V1704A and rectified by rectifier CR1703. This positive dc voltage is also applied to V4802.

(3) When the phase detector input frequency and phase detector reference frequency are not alike, phase detector CR1708 produces an ac output voltage which is applied to control amplifier V4801. This stage amplifies the alternating current (ac) voltage and applies it to rectifier circuit CR4801 and CR4802. The output of these rectifiers is a negative voltage which cuts off V4802.

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(*a*) Assume that a signal of 1,700 kc is to be monitored (fig. 9). This 1,700-kc signal is applied to first mixer-amplifier V1401. At this frequency, this stage functions as an ordinary RF amplifier whose output is applied to second mixer-amplifier V1402.

(*b*) Tube V1402 mixes the 1,700-kc signal with a 2,000-kc frequency from the smo and a resulting 300-kc signal is applied to first 300-kc amplifier V1403.

(*c*) The output from V1403 is coupled through cascaded second and third 300-kc amplifiers V1404 and V1406A, deetected by rectifier CR1401, and applied to meter M801 (METER SWITCH in position 1).

(*d*) The output from V1403 is also applied to demodulator V1405. Here it is mixed with a 300-kc signal from the frequency standard compartment.

(*e*) The 300-kc signal from V1403 mixes with the 300-kc signal from the frequency standard. The difference frequency (audio) is applied to V1406B. The audio output of this stage is made available at terminals 31 and 32 of P802 in the exciter-monitor chassis. Note that this audio output is intelligible only if a single-sideband transmission is monitored. Normally, this facility is used for test purposes rather than for aural monitoring.

(4) When the monitor circuit is used to receive signals in the bands 3 through 5 range, the following actions take place:

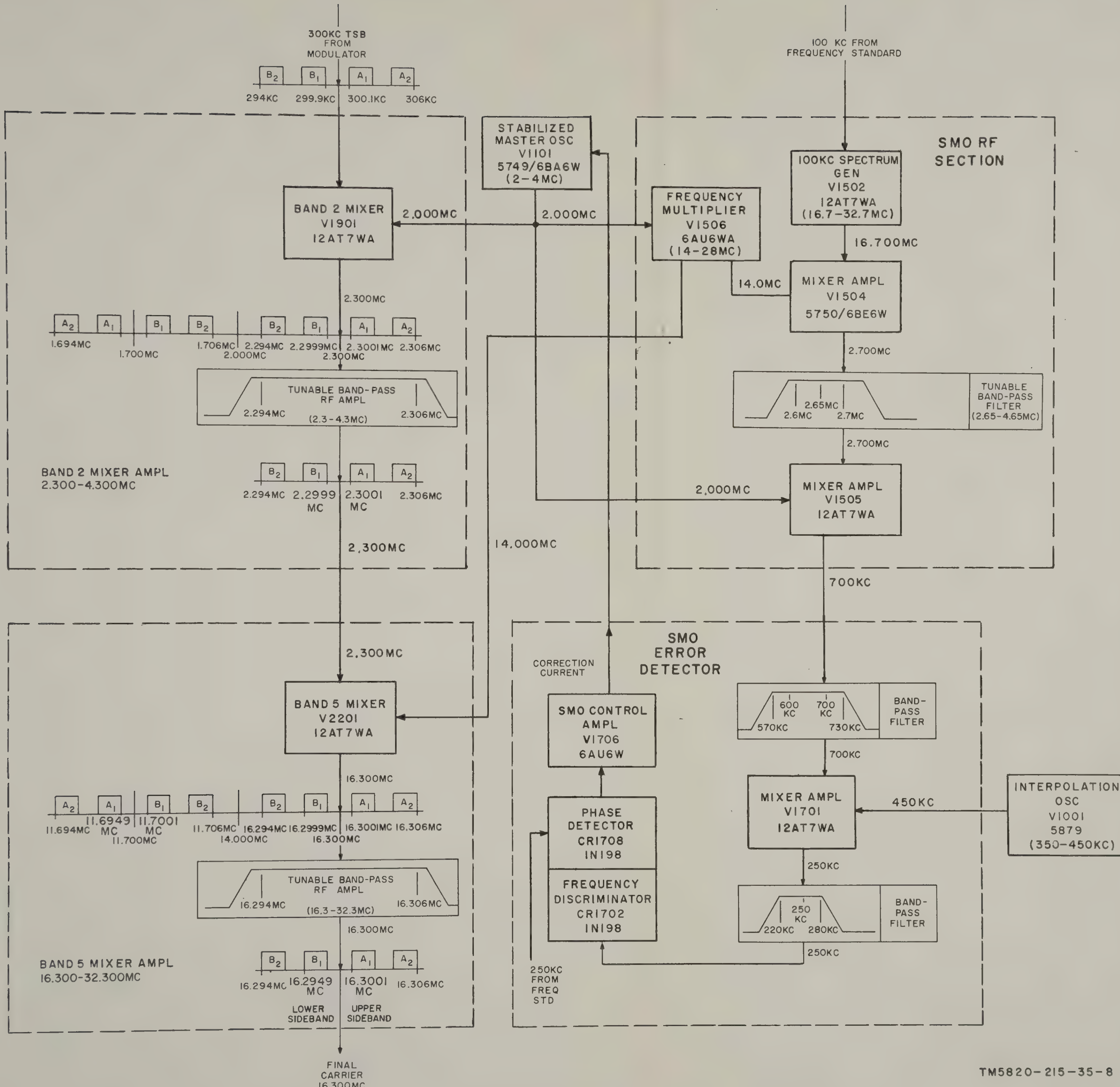

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Figure 8. Exciter-monitor frequency scheme, band 5, dial setting 16.3000 mc, 0.5 KC LOCK switch OFF.

(*a*) Assume that a signal of 8,300 kc is to be monitored (fig. 10). This signal is applied to V1401 where it is mixed with a 6,000-kc signal from one of the mixer-multiplier stages within the smo RF section. Note that V1401 functions as a mixer in this application. The output of V1401 is a difference frequency of 2,300 kc and is applied to second mixer-amplifier V1402.

(*b*) The 2,300-kc signal is mixed in V1402 with a 2,000-kc signal from the smo. The resulting 300-kc output signal is treated in the same manner from this point as that described in (3) above.

(5) When the monitor circuit is used to monitor a 300-kc tsb signal or a 300-kc test frequency, both mixer-amplifiers (V1401 and V1402) function as amplifiers and no mixing frequencies are applied to these two stages.

7. Exciter-Monitor Tuning

(fig. 11)

a. The exciter-monitor tuning system includes thre controls; BAND, FREQ-KC, and FREQ-MC. These controls are operated simultaneously and automatically by an electromechanical device that positions the tuning elements of the exciter-monitor to exact, predetermined positions. The system provides for selection of 10 preset channels by operation of a CHANNEL selector switch. When the locking keys for each of the three tuning controls are loosened, the exciter-monitor can be tuned manually (TM 11–5821–212–10).

b. The frequency range of this equipment is divided into five bands. Operation of the band switch to a desired band connects the required mixer-amplifier circuit (par. 6*a*) and connects the smo and multiplier circuits that supply conversion frequencies to the mixer-amplifiers. It also connects tuning circuits of the 100-kc spectrum generator (par. 6*b*(6)) so that a standard signal at the required frequency is developed for frequency control circuits.

c. To provide continuous tuning over the entire frequency range (1.7—32.3 mc), the following circuits must respond to the operation of all three controls:

(1) Stabilized master oscillator tuning coil.

(2) Mixer-amplifier tuning coils.

(3) Mixer-amplifier bias potentiometers.

(4) Smo RF section circuits.

(5) The 100-kc spectrum generator.

d. The FREQ-KC, FREQ-MC, and BAND controls are mechanically coupled to the input of the mechanical interpolator. The tuned circuits listed in *c* above are mechanically coupled to the output of the mechanical interpolator.

e. The setting of the various tuned circuits (*c* above) in the exciter-monitor is controlled by the FREQ-MC control through the mechanical interpolator. The rate of rotation of the FREQ-MC shaft is directly translated to the controlled tuned circuits on bands 1 and 2. Twice the rate of rotation is translated on band 3, four times the rate on band 4, and eight times on band 5. Mechancial interpolation is necessary because of the frequency multiplication used on the higher bands.

f. The FREQ-MC control tunes in 0.1-mc steps; a mechanical detent accurately locates the 0.1-mc positions. The mechanical interpolator selects the detent wheel with the correct number of detent notches for each band selected by the band control. The frequency reading is displayed on a different set of counter wheels for each band.

g. The position of the FREQ-KC tuning shaft is read on counter wheels that cover a 100-kc range. On each band, rotation of the shaft for the complete 100-kc range must change the tuning of the stabilized master oscillator and selected mixer-amplifier circuits through a range equivalent to a 0.1-mc change of the FREQ-MC control for that band. The required amount of rotation at the output of the mechanical interpolator caused by full rotation of the FREQ-KC control is the same for bands 1 and 2, one-half as much on band 3, one-fourth as much on band 4, 2nd one-eighth as much on band 5. The mechanical interpolator is set by the BAND control to change the mechanical ratio between the FREQ-KC (and FREQ-MC) control shaft and the mechanical interpolator output according to the required ratios. The interpolation oscillator tuning circuits (par. 6*c*) and the 0.5-kc spectrum detent tuning are operated throughout their full range by operation of the FREQ-KC control only.

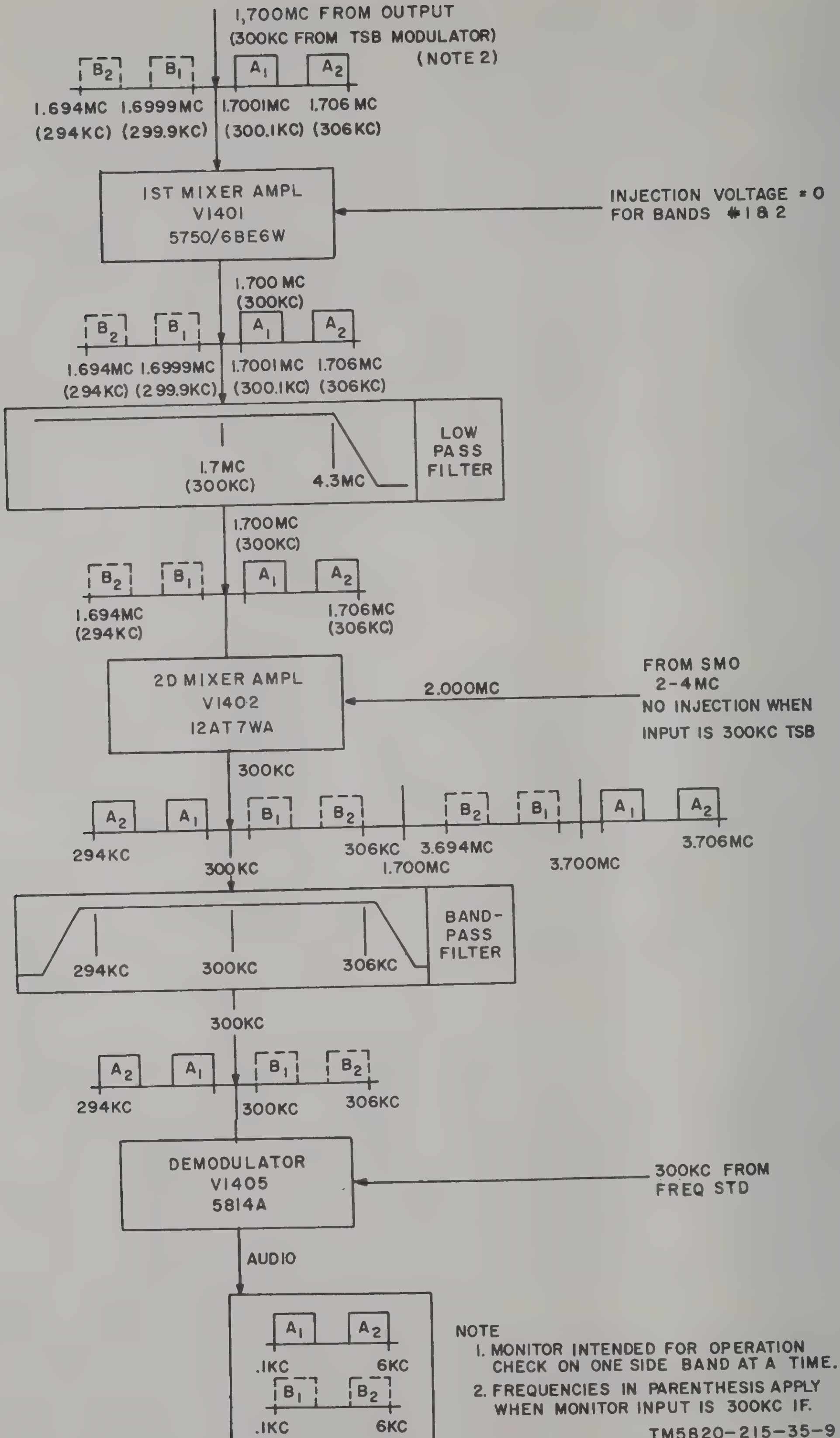


Figure 9. Monitor circuit frequency scheme, bands 1 and 2, dial setting 1.7000 mc.

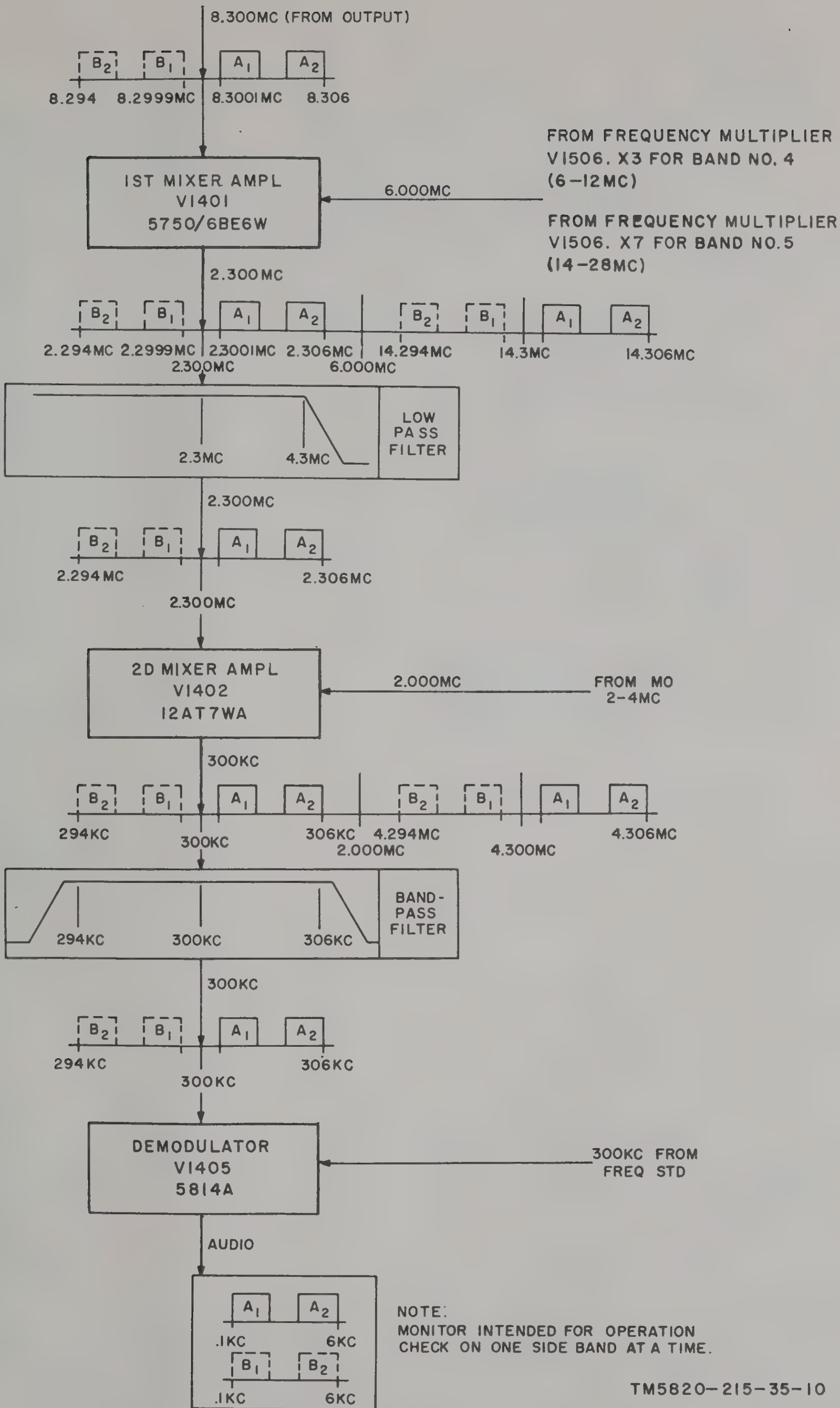


Figure 10. Monitor circuit frequency scheme, band 4, dial setting 8.3000 mc.

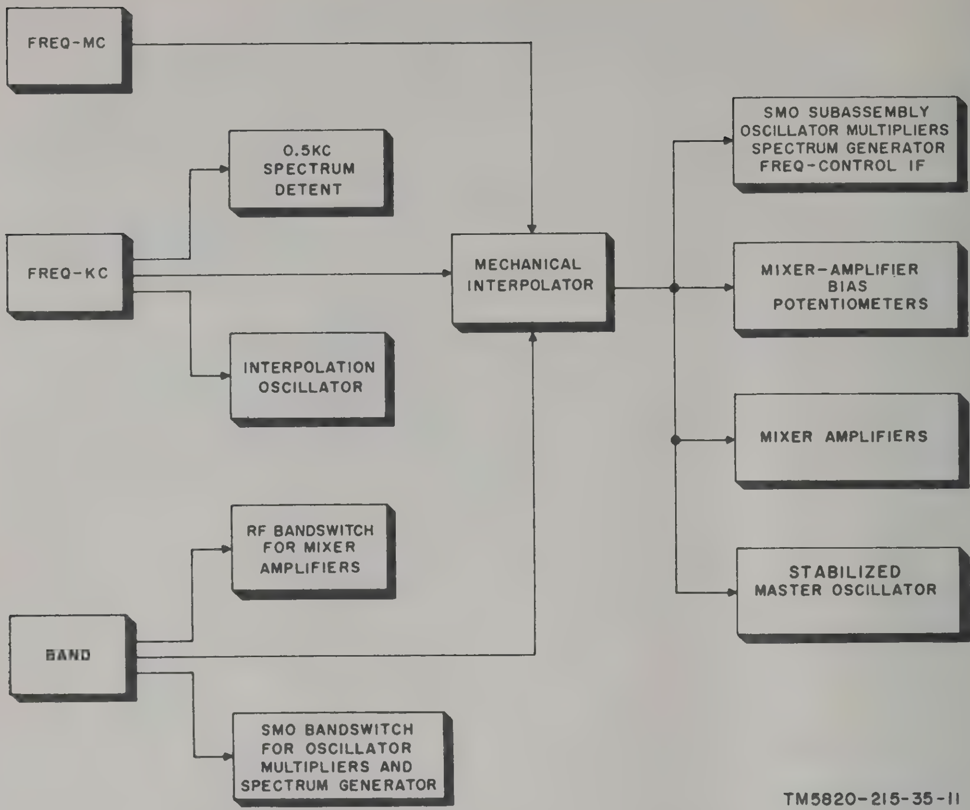


Figure 11. Exciter-monitor tuning system, block diagram.

CHAPTER 2

THEORY OF TWIN-SIDEBAND MODULATOR

Section I. TWIN-SIDEBAND GENERATOR

8. General

This theory portion supplements the block diagram coverage in paragraph 4. It is suggested that the reader review that paragraph before reading the material presented in this chapter. The procedure for the generation of sideband frequencies in this equipment is identical regardless of the eventual output frequency obtained from the exciter-monitor compartment. Similarly, none of the inputs to the modulator, i.e., 100-kc carrier signal, audio, control, and supply voltages, depend upon the frequency of operation.

9. V201, 100 Kc Amplifier

(fig. 12)

a. A 100-kc sine wave signal from the frequency standard (par. 35*b*) is coupled to V201, a type 6AU6WA pentode, through C202 and is developed across R203. The input signal is amplified by V201 and appears across plate-tuned circuit L201, C201, and C215. The voltage developed across the tuned circuit (approximately 280 volts peak to peak) is applied to a squaring circuit (par. 10).

b. Cathode bias is developed across R204 and C203. This stage is disabled by relay K202 which, when activated, removes the cathode ground from V201. Screen grid and plate potentials are supplied through R206; C205 bypasses RF at the junction of R206 and R205. Resistor R205 is the screen grid voltage-dropping resistor and C204 is the screen grid RF bypass. Inductor L202 and C206 are a 300-volt supply decoupling network. Test points TP207 and TP201 permit access to the cathode and plate of V201 for measurements.

10. Square Wave Generator

(fig. 13)

a. The square wave generator consists of two pairs of diode clippers, CR201 with CR202 and CR203 with CR204. The first pair of diode clippers

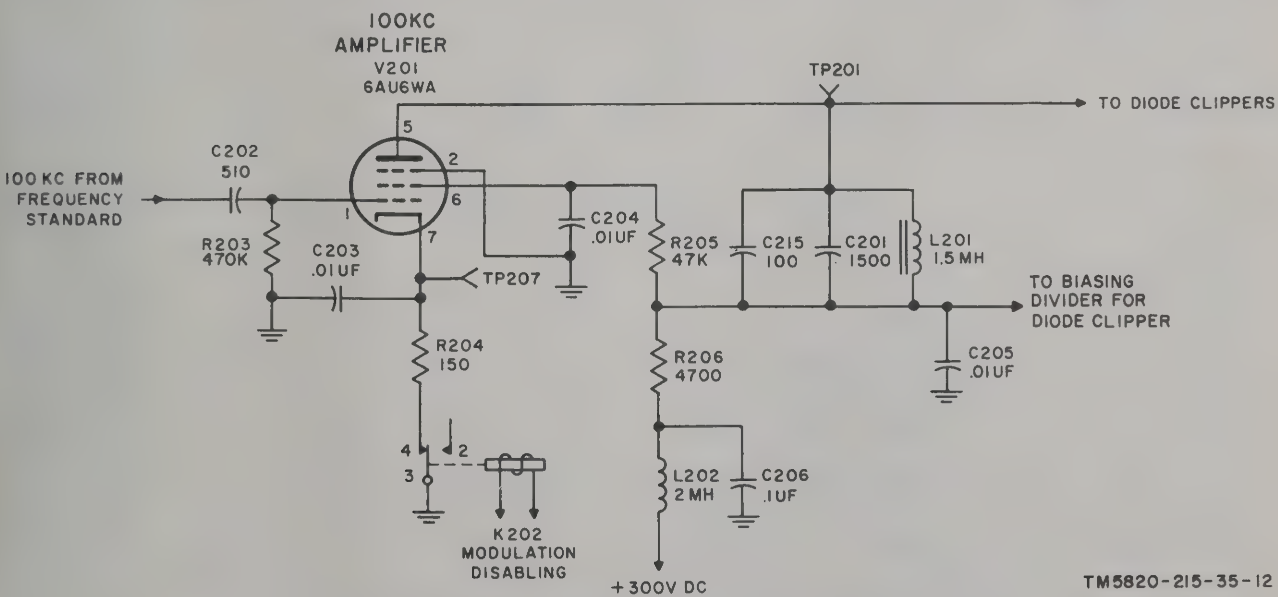


Figure 12. 100-kc amplifier circuit, schematic diagram.

CR201 and CR202, reduces the 280-volt peak-to-peak input signal to a 10-volt peak-to-peak square wave. The second pair of diode clippers, CR203 and CR204, reduces the 10-volt peak-to-peak square wave to a 1-volt peak-to-peak square wave.

b. Voltage divider R207, R262, and R263, connected across the +300-volt supply, provides the bias for the clipping diodes. The cathode of CR201 is biased at +10 volts with respect to ground and the cathode of CR202 is at +5 volts with respect to ground because of voltage division between the two diodes. Diode CR201 conducts when the input frequency amplitude in the positive direction exceeds 5 volts. This action limits each positive half-cycle to a peak amplitude of 5 volts. On the negative half-cycle of the input signal, when the amplitude exceeds 5 volts, CR202 conducts and limits the negative swing to 5 volts. Resistor R208 limits the maximum current that may be drawn through the diodes, and C223 is a dc blocking and ac coupling capacitor.

c. Diode clippers CR203 and CR204 are connected across a 1-volt dc source. This circuit operates similarly to the limiter covered in *b* above except that the 10-volt peak-to-peak input is clipped to 1 volt peak to peak. This second clipping is necessary because the diodes slightly round the peaks of the first clipped wave. The output of the second clipping circuit is essentially square.

11. Square Wave Amplifiers V202 and V203
(fig. 14)

The 100-kc input square wave signal from the square wave generator (par. 10) is applied through C222 to the control grids of two dual-triode tubes V202 and V203. The control grids of these tubes are parallel-connected while the plates are connected to separate plate transformers T206 and T209. Since the functions of V202 and V203 are identical, only the detailed operation of V202 will be covered. The square wave input causes V202 plate current variations in the primary of T206. This action induces a 100-kc square wave into the secondary of T206. Resistors R253 and R254 are parasitic oscillation suppressors. Resistor R251, shunted by bypass capacitor C218, provides cathode bias. Plate decoupling is furnished by R255 and C213. Test point TP202 provides access for cathode voltage measurement of V202. Corresponding circuit components in the V203 stage perform the same functions as those in the V202 stage.

12. Balanced Modulator
(fig. 15)

a. Figure 15 illustrates the balanced modulators used to generate the twin-sideband signal. Since both modulators are identical except for reference symbols, only the balanced modulator in the upper half of the illustration will be discussed. Two input

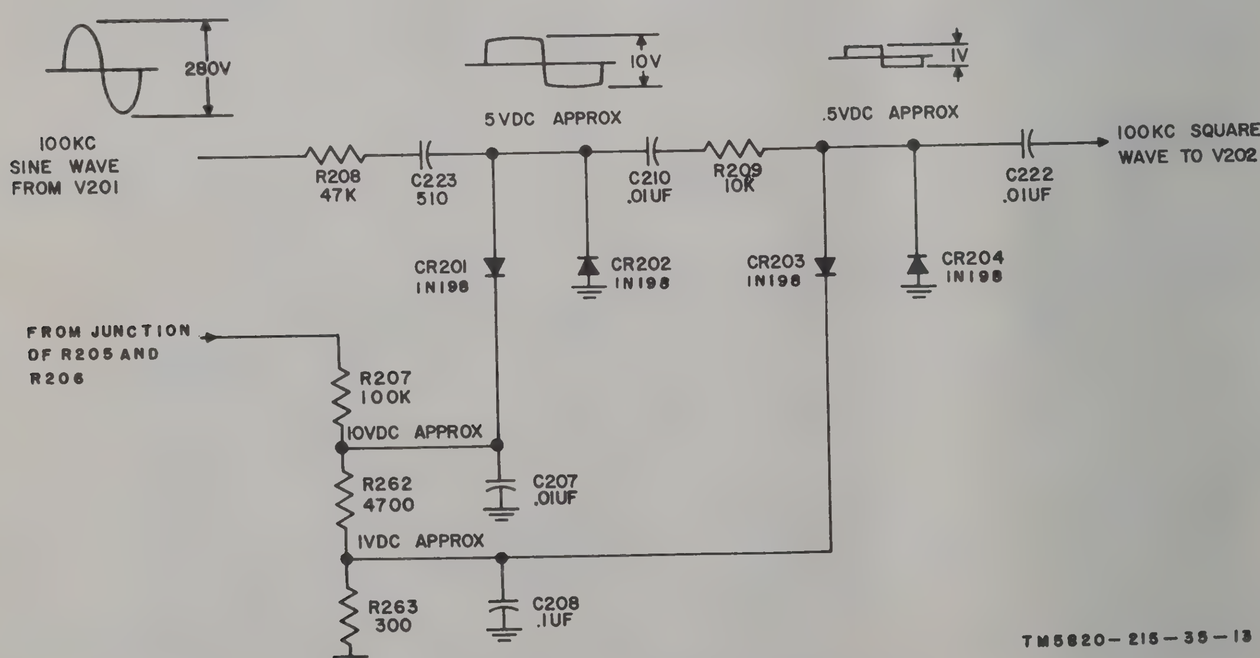


Figure 13. Square wave generator, schematic diagram.

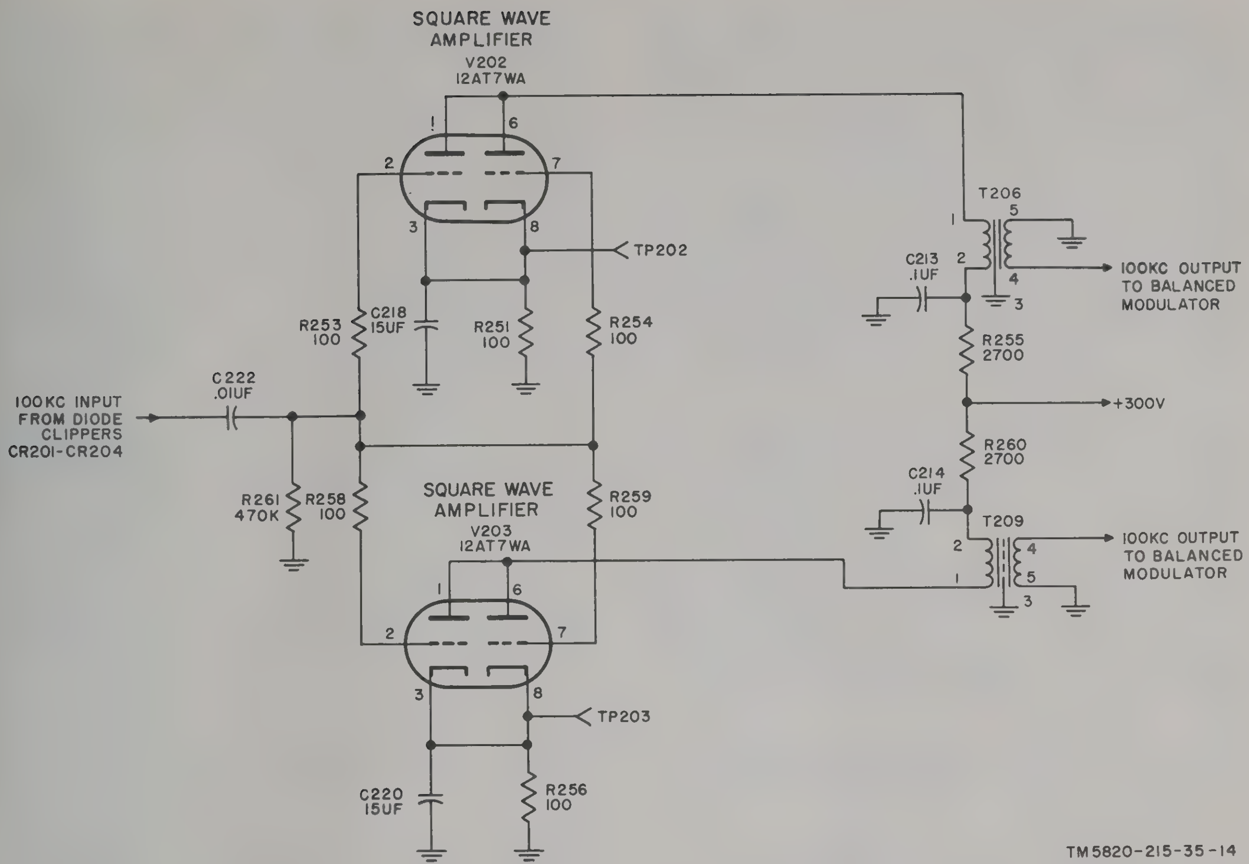


Figure 14. Square wave amplifiers V202 and V203, schematic diagram.

waves are applied to the modulator, one is the 100-kc square wave (par. 11) and the other an audio signal ranging from 100 cps to 6 kc. The output of this modulator, appearing across the secondary of T207, consists of an upper sideband (100.1 to 106 kc) and a lower sideband (94 to 99.9 kc). The 100-kc square wave carrier is balanced out and does not appear across the secondary of T207.

b. The amplitude of the 100-kc square wave input at the secondary of T206 is about 10 times the amplitude of the audio signal applied to T205. Therefore, the 100-kc square wave determines the instantaneous polarity across the crystal diodes. The 100-kc square wave keys diodes CR205A and CR205B and CR206A and CR206B in pairs. The nonconducting pair of diodes has an effective resistance of approximately 2 megohms. The conducting pair has a forward current of approximately 5 milliamperes (ma) giving it an effective resistance of approximately 200 ohms. The advantage of using a square wave to switch the diodes from a conducting state to a nonconducting state improves the desired-to-undesired signal power-output ratio in two ways. First, by switching the diodes as rapidly as possible (steep wave front), the nonlinear characteristics of the diodes are minimized; secondly, by using a flat-topped switching waveform, the carrier leak, due to stray coupling of 100-kc component from primary to secondary of T207, is minimized.

c. When the circuit is in balance, that is, with balance potentiometers R235 and R238 set correctly, the 100-kc carrier currents, in the T207 primary windings on each side of the balance potentiometer in the section containing the conducting pair of diodes, are equal and opposite in phase. As a result, the circuit currents are in opposition and no voltage at that frequency is induced in the secondary winding. However, the audio signal causes a single current to flow through the transformer primary, and a voltage is induced in the secondary winding. For example, assume an audio voltage impressed across the secondary of T205 is such that pin 4 is negative with respect to pin 6. Also assume that the RF square wave polarity at this instant is such that CR205A and CR205B are

conducting and may be considered as two 200-ohm resistors. The audio current that flows at that instant is from pin 4 of T205, through CR205A, windings 1–4 and 5–2 of T207, through CR205B, and back to pin 6 of T205. When the RF square wave reverses polarity, CR205A and CR205B are effectively open-circuited, but CR206A and CR206B conduct. The voltage induced into the secondary of T207 contains the sum and differences of the carrier frequency and the audio signal. The carrier frequency itself does not appear in the secondary winding.

d. Resistors R231 and R232 and capacitor C228 form an impedance matching network. Capacitors C224 and C225 resonate the primaries of T207 at 100 kc, making the use of purely resistive balance networks more effective. The 30-ohm resistors, R236, R237, R239, and R240 connected across the balance potentiometers, reduce the effective resistance and provide vernier balance adjustment. Resistors R233 and R234 isolate the separate primaries of T207.

13. Sideband Filter and Carrier Reinsert Circuit
(fig. 16)

a. The output signals from the balanced modulators (par. 12) are impressed across the secondaries of T207 and T210. Both signals are in the form of upper and lower sidebands on either side of 100 kc. The sideband filters in this section pass the upper sideband of one signal and the lower sideband of the other. The outputs of the filters are then added in opposition to cancel residual reactive carrier unbalance, which otherwise could not be balanced out with the resistive balance potentiometers (fig. 15). A controlled carrier level is added at this point. When this equipment is used for amplitude modulation, the audio inputs are paralleled and full carrier is reinserted.

b. The double-sideband signal at the secondary of T207 is coupled to crystal sideband filter Z204 through a 10-decibel (db) pad consisting of R223, R224, R225, and R226. The double-sideband signal at the T210 secondary is coupled to crystal sideband filter Z205 through a 10-db pad consisting of R227, R228, R229, and R230. The pads reduce the effect of varying load impedance presented to the balanced modulators by the crystal sideband filters. Such variations in load impedance increase distortion in the balanced modulator which appears within the desired sideband. Crystal sideband filter Z204 passes frequencies between 94 and 100 kc, thus eliminating the upper sideband from the T207 input. Crystal sideband filter Z205 passes frequencies be-

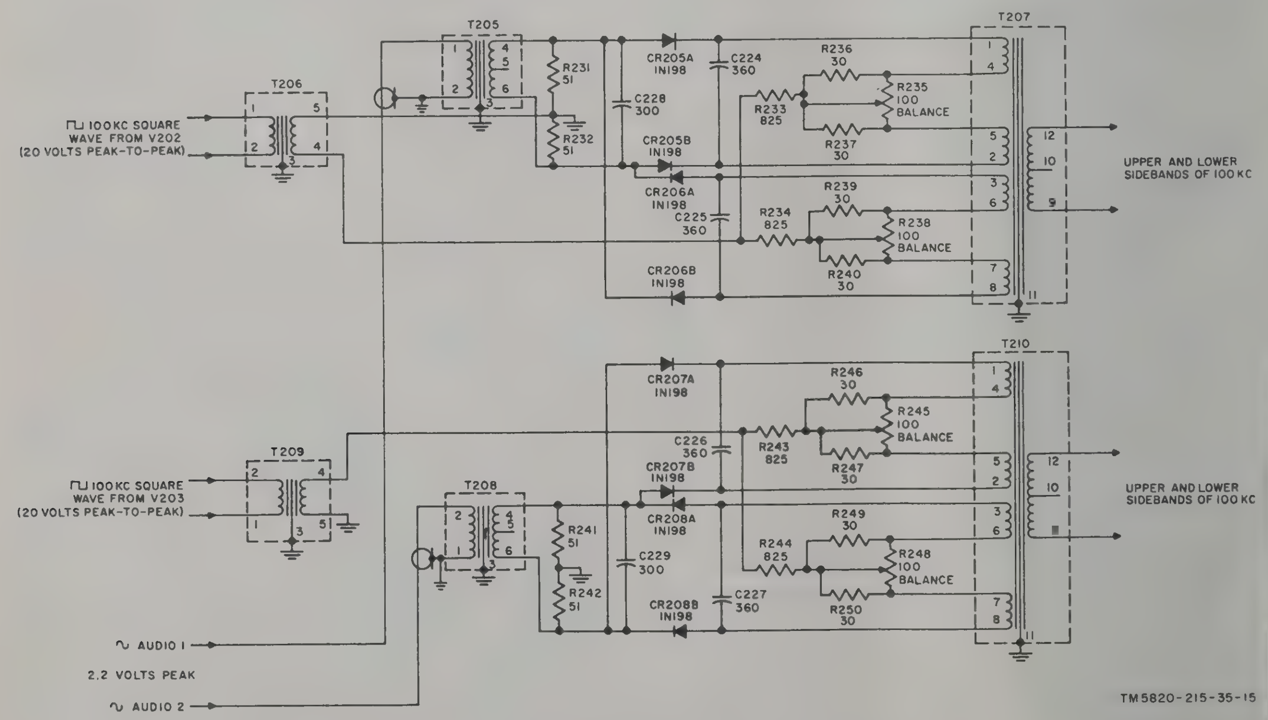


Figure 15. Balanced modulators, schematic diagram.

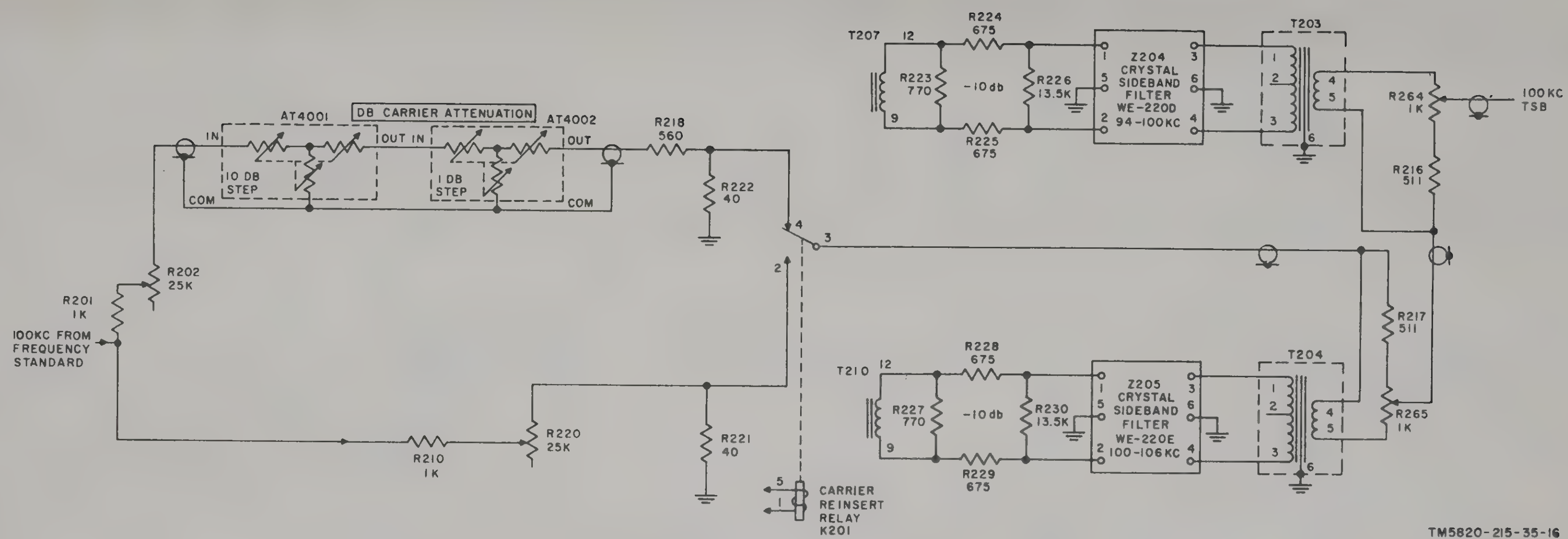


Figure 16. Sideband filter and carrier reinsert circuit.

tween 100 and 106 kc, thus eliminating the lower sideband from the T207 input.

c. The 100-kc carrier is combined with the combined sideband signals at the secondaries of T203 and T204. The 100-kc carrier is coupled through attenuation adjustment control R202 and maximum loading resistor R201 to the variable DB CARRIER ATTENUATION control. The DB CARRIER ATTENUATION control is a front panel control that introduces carrier attenuation in fixed steps. Attenuator AT4001 attenuates the carrier in 10-db steps, and AT4002 attenuates the carrier in 1-db steps. Resistors R218 and R222 match the attenuation network to the transformer secondaries of T203 and T204. Relay K201 is activated during tuneup procedure, applying a fixed-carrier level through closed contacts 2 and 3 to the power amplifier stage in Radio Frequency Amplifier AM–1154A/G. This carrier level is adjusted by R220 during alinement procedures. Resistor R210 is a maximum loading resistor; the fixed level carrier is developed across R221. When the tuneup procedure is completed, relay K201 is deactivated and the desired attenuated 100-kc signal from the frequency standard is coupled into the transformer secondaries of T203 and T204 through closed contacts 3 and 4. Resistors R264 and R265 are adjustment controls that determine the signal amplitude coupled to V4201 (par. 14); resistors R216 and R217 are impedance matching resistors.

Section II. FREQUENCY CONVERTER AND FREQUENCY MULTIPLIER STAGES

14. Frequency Converter V4201
(fig. 17)

a. The 100-kc twin-sideband signal from the tsb generator is directly coupled through parasitic oscillation suppressor R4208 to the control grid of V4201. A 400-kc signal from frequency multiplier V4101 is coupled through C4201 to the injector grid (pin 7) of V4201. The 100-kc tsb signal mixes with the 400-kc signal, producing sum and difference frequencies. The difference frequency of 300 kc and the two sidebands are coupled through 300-kc bandpass filter Z4202 to the following stage.

b. Resistor R4201 is the injector grid resistor for the 400-kc signal, and R4202 is the control grid resistor for the 100-kc tsb input signal. Cathode bias is provided by R4203 and C4204. Test point TP4202 provides access for monitoring the cathode voltage of V4201. The screen grid voltage-dropping resistor is R4207, and C4203 is the screen grid bypass. Decoupling for the 300-volt supply is provided by

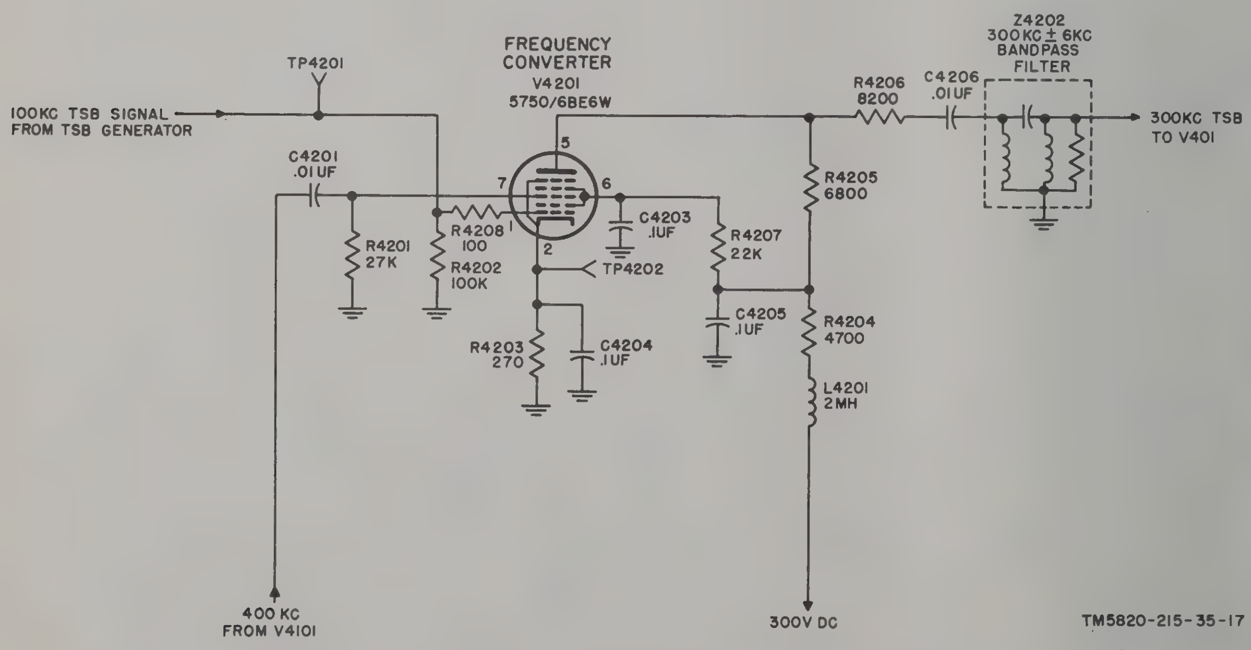


Figure 17. Frequency converter V4201, schematic diagram.

R4204, L4201, and C4205. Resistor R4205 is the V4201 plate load, and resistor R4206, capacitor C4206, and filter Z4202 are part of the coupling network that delivers the 300-kc tsb signal to the first controlled-gain amplifier (par. 17).

15. Frequency Multiplier V4101
(fig. 18)

a. Frequency multiplier V4101 accepts a 100-kc signal from the frequency standard compartment and multiplies it by 4 to produce a 400-kc output signal that is applied to frequency converter V4201 (par. 14).

b. The 100-kc input is coupled through C4101 and is developed across 100-kc tuned circuit Z4101. The 100-kc signal is coupled through C4104 to the control grid of V4101A. The amplified output of V4101A is applied to tuned circuit Z4102, which is tuned to the second harmonic of 100-kc. The 200-kc voltage is coupled through C4108 to the control grid of V4101B. The amplified output of V4101B is applied to Z4103, which is tuned to 400-kc. The 400-kc output of Z4103 is coupled through C4112 to Z4104, which is also tuned to 400-kc. The 400-kc output of Z4104 is coupled through C4201 (fig. 17) to frequency converter V4201.

c. Plate decoupling is provided by R4101 and C4107 for V4101A and by R4104 and C4111 for V4101B. Additional decoupling for the +300-volt line is provided by L4105 and C4119. Resistors R4102 and R4103 are the grid leak resistors for the two triode sections of V4101. Capacitor C4106 is effectively part of the tuned circuit for Z4102 and forms a capacitive voltage divider for the signal that is coupled to V4101B. Capacitors C4115, C4116, and C4120 filter noise and harmonics of 400 kc out of the 400-kc line. Test points TP4101, TP4102, TP4103, TP4111, TP4112, TP4113, and TP4114 provide easy access for voltage measurement of the critical circuits within this stage.

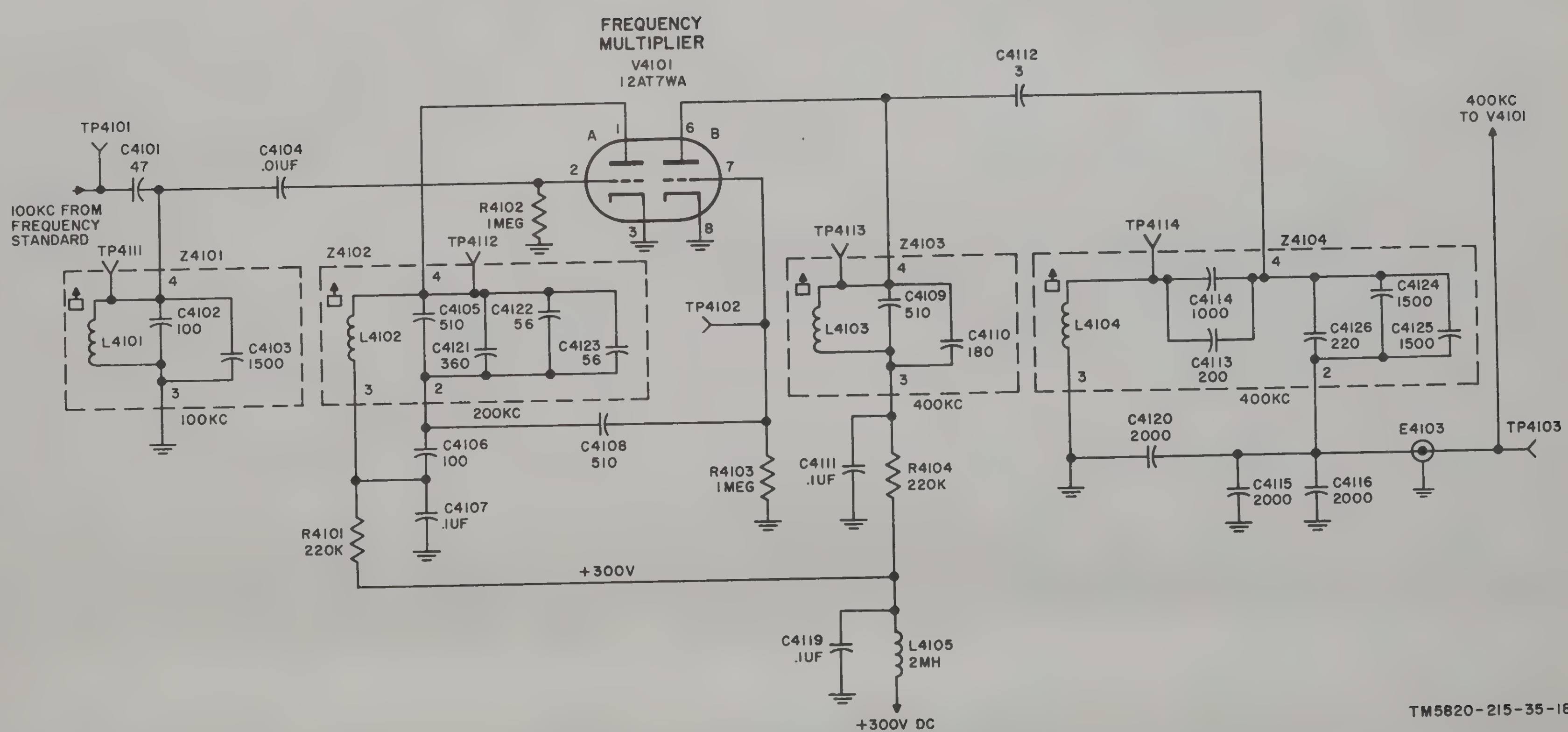


Figure 18. Frequency multiplier V4101, schematic diagram.

16. Automatic Load Control Theory

The modulator-oscillator group is normally used with Radio Frequency Amplifier AM–1154A/G (TM 11–5821–212–10 and TM 11–5820–350–35) serving as the power amplifier. The automatic load control (alc) circuit contained within the tsb modulator chassis makes possible the use of full power-output capabilities of the power amplifier when only one sideband is being used without danger of distortion due to overloading when the other sideband is put into use. A rectifier circuit monitors the output of the power amplifier stage of Radio Frequency Amplifier AM-1154A/G. The negative dc voltage developed by this rectifier is an alc voltage that is fed as bias to the controlled-gain amplifiers in the modulator-oscillator group. The controlled-gain amplifiers control the amplitude of the 300-kc tsb signal. Maximum gain is permitted until a level near peak power output from the power amplifier stage is reached. When this level is exceeded, an increase in alc voltage from the alc rectifier in the power amplifier stage of Radio Frequency Amplifier AM–1154A/G is fed to the controlled-gain amplifier to reduce the gain. Compression of high-level, overdriving signals is thereby achieved.

17. First Controlled-Gain Amplifier V401 (fig. 19)

a. The 300-kc tsb signal from the frequency converter stage (par. 14) is coupled through C401 to the control grid of V401. When ALC switch S401 is placed at ON, the control grid of V401 is returned through grid resistors R401 and R402 to a source of negative dc (alc) voltage that determines the gain of V401 (and V402); C402 prevents the 300-kc tsb signal current from affecting the alc line. When S401 is placed at OFF, grid resistors R401 and R402 are returned to ground, and the stage operates as an ordinary RF amplifier with its gain controlled by the bias voltage developed across cathode resistor R403 and cathode bypass capacitors C403 and C411. The amplified output of V401 is applied to tuned circuit Z401 and coupled through capacitors C407 and C419 to tuned circuit Z402. The 300-kc tsb output of Z402 is applied to second controlled-gain amplifier V402 through C409.

b. The approximate amount of alc compression is indicated on meter M4001. (Meter M4002 performs the same function; it is not shown in fig. 19.) Resistor R420 is calibrated (par. 130*f*) to provide the correct meter level prior to alc voltage application from the power amplifier. When the voltage between the tap of R422 and ground exceeds the voltage between the tap of R420 and ground, CR401 conducts and the meter provides a reading that is directly proportional to the current through V401 and V402, and inversely proportional to the alc voltage applied to the alc amplifier.

c. The screen grid of V401 is returned to +125 volts dc through screen grid voltage-dropping resistor R405. Capacitor C404 is the screen grid bypass. Resistors R419 and R420 are connected across the +125-volt supply and form a variable voltage divider for biasing M4001 (*b* above). Capacitor C424 bypasses the 300-kc component in the meter current to ground. Capacitor C425 and inductor L405 decouple the screen grid from the +125-volt line. Capacitor C406 and R407 are a plate decoupling network for V401. Test point TP407 permits monitoring of the cathode voltage, TP401 provides access to the plate tank of V401, and TP405 permits monitoring of the negative dc voltage applied from the alc rectifier in Radio Frequency Amplifier AM–1154A/G. Alc voltage is impressed across resistors R416 and filtered by R417 and capacitor C422.

18. Second Controlled-Gain Amplifier V402 (fig. 19)

The 300-kc output of V401 is applied to V402 and is developed across R409. Resistor R408 and capacitor C410 form a filter network that shunts RF away from the alc lines. Except for reference symbols, this stage is similar to V401. The output of V402 is developed across tuned circuit Z403 and is coupled to the exciter-monitor stages for conversion to the desired frequency to be used for transmission. The 300-kc tsb output is also coupled as a reference voltage to the agc unit (par. 20*a*).

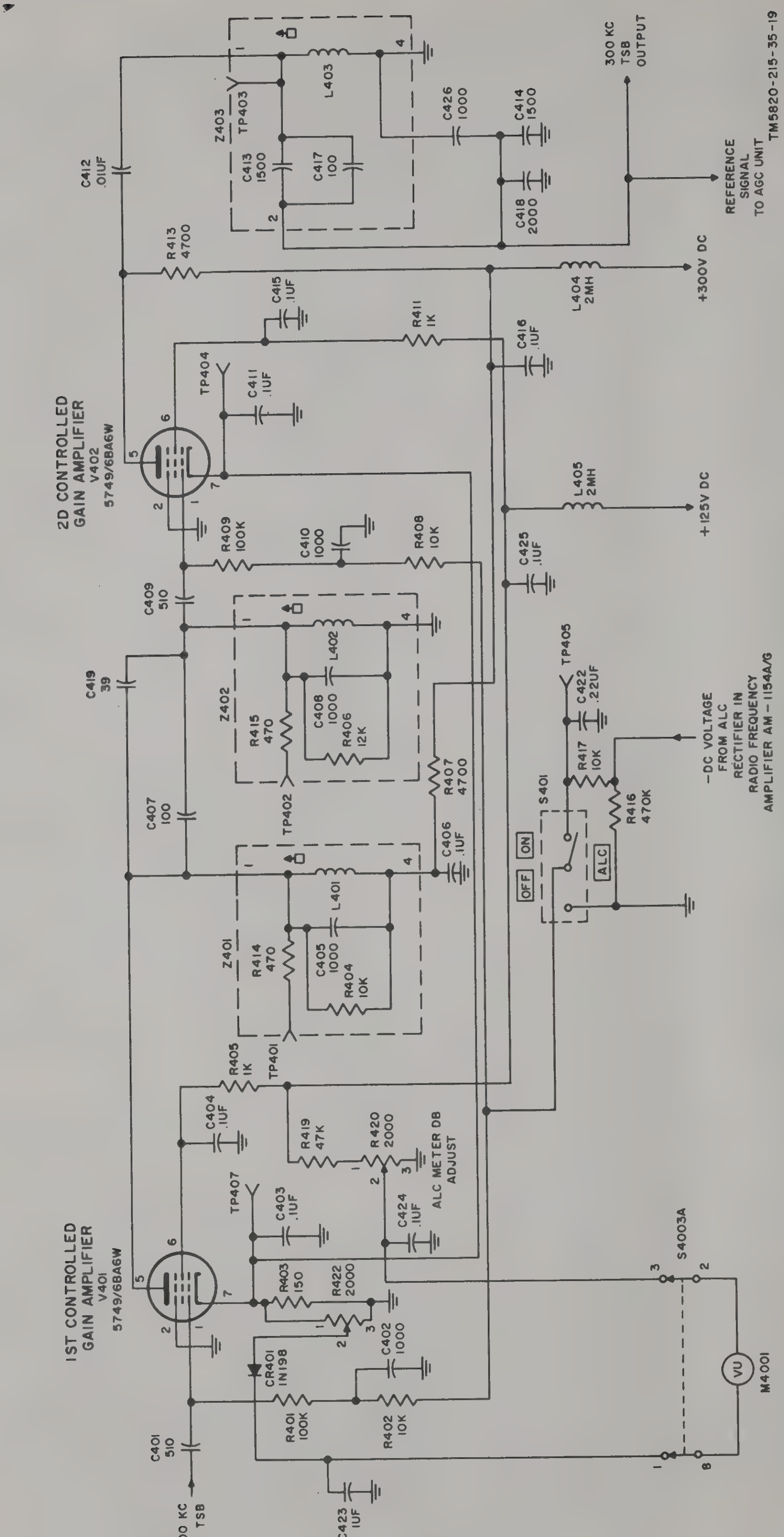


Figure 19. Automatic load control circuit, schematic diagram.

19. Automatic Gain Control Function

(fig. 20)

The agc circuit prevents changes in the amplitude of the driving signal to the power amplifier of Radio Frequency Amplifier AM–1154A/G that may occur because of a change in the signal level applied to the mixer-amplifiers or a change in tube and component characteristics in the exciter-monitor. The agc circuit functions by comparing a reference voltage from the second controlled-gain amplifier (par. 18) with a dc voltage derived from a sample of the power amplifier output. If the driving signal at the power amplifier changes, a control voltage is developed that causes motor B4501 to turn. This motor is ganged to a bias control potentiometer in the mixer-amplifier grids. The bias and therefore the gain of the mixer-amplifiers is adjusted so that the output from the exciter-monitor chassis to Radio Frequency Amplifiers AM-1154A/G remains relatively constant.

20. Agc Amplifier V4501

(fig. 20)

a. Agc amplifier V4501 is a buffer amplifier that accepts the 300-kc tsb signal from second controlled-gain amplifier V402. The output of V4501 is rectified by CR4501 to provide a positive voltage referenced to one side of LEVEL potentiometer R4505 and proportional to the exciter-monitor input. The 300-kc twin-sideband signal from the controlled-gain amplifier chassis is coupled through C4505, developed across grid resistor R4501, and applied to the control grid of V4501. The amplified output of V4501 is applied to 300-kc tuned circuit C4504 and L4501. The voltage across this tuned circuit is coupled through C4506 and applied across inductor L4502. The voltage across L4502 is rectified by CR4501 and filtered by C4507; the dc voltage is developed across R4506. This voltage is applied to one side of LEVEL potentiometer R4505.

b. Cathode bias for V4501 is provided by R4502 and C4501. Resistor R4503 and C4502 are the screen grid voltage-dropping resistor and screen grid bypass capacitor. Plate decoupling is provided by R4504 and C4503.

21. Dc Amplifier and Agc Control V4502

(fig. 20)

a. The agc rectifier in the power amplifier (part of Radio Frequency Amplifier AM–1154A/G) supplies a negative voltage to LEVEL control R4505 that is proportional to the power amplifier output. The position of the slider on R4505 determines the amount of negative voltage required to balance the positive voltage supplied by CR4501 (par. 20), and thus determines the amount of gain required between the input of the exciter-monitor and the output circuit of the power amplifier.

b. Tube V4502 is connected in a bridge circuit consisting of R4509, V4502A, R4518, R4511, R4517, V4502B, and R4510. The control grid of V4502A is connected through isolation resistor R4507 to the arm of LEVEL control R4505. The bridge circuit is adjusted to be in balance when the junction of the arm of R4505 and R4507 is grounded by agc switch S4501 in the BAL position. When the bridge is balanced, no difference in potential exists between the two plates of V4502, and no current flows through agc bias control relay K4501, windings 5–7 and 3–1. In this condition, the relay remains deactivated. Relay K4501 is a polarized relay.

c. Assume that there is insufficient gain in the mixer-amplifier stages and a low amplitude twin-sideband excitation signal is being applied to Radio Frequency Amplifier AM–1154A/G. The power amplifier output is reduced and the negative voltage rectified by CR5003 (fig. 110, TM 11–5820–350–35) falls. The agc voltage applied to LEVEL control R4505 also falls and the bias applied to V4502A decreases, thereby increasing the gain of V4502A. The increase in gain of V4502A upsets the bridge balance because the plate voltage of V4502A is reduced. Plate, pin 1, becomes negative with respect to plate pin 6 and current flows through bias control relay K4501 windings 5–7 and 3–1. Under this condition, polarized relay K4501 terminal 1 is more positive than terminal 5 and contacts 6 and 8 close. Resistor R4514 is shorted out and current flows through windings A and B of motor B4501. The motor turns in a direction to reduce the biasing voltage developed across R4513. This reduces the bias applied to the mixer-amplifiers in the exciter-monitor, and thereby increases the gain of these stages and the amplitude of the tsb signal delivered to the power amplifier. If there is excessive gain, the conditions are reversed. The bridge is unbalanced in the opposite direction, and motor B4501 turns R4513 to reduce the gain of the mixer-amplifiers.

d. Relay K4502 is controlled by agc disabling circuits and switch S4501. When agc switch S4501 is at OFF, the ground return for the relay coil of K4502 is opened. This action deenergizes the relay, and contacts 6–13 and 1–14 open. With contacts 6–13 open, motor B4501 stops because the field winding return to 12.6 volts ac is open; with contacts 1–14 open, the B+ path to the plates of V4502 is broken. In this condition, only manual adjustment of R4513 is possible. When switch S4501 is at NORM, pin 8 of relay K4502 is normally returned to ground through the agc disabling circuits, and circuit operation is as described in *c* above. However, during the tuning cycle, the disabling circuit breaks the ground return for the K4502 relay coil and disables the agc circuit. In the BAL position, terminal 8 of K4502 is grounded and resistor R4511 is adjusted to balance the bridge circuit.

e. Indicator L4503 and capacitor C4513 decouple both V4501 and V4502 from the +300-volt line. Capacitor C4508 bypasses to ground any RF that may be present on the grid of V4502A. Resistor R4512 is the grid return resistor for V4502B. Resistors R4509 and R4510 are cathode biasing resistors for the two tube sections, and resistors R4518 and R4517 are the individual plate load resistors. Resistor R4508 is a sensitivity control that shunts agc bias control relay K4501 and R4511 is for balancing of the bridge circuit when R4507 is grounded through the BAL contacts of S4501. Resistors R4514, R4515, and capacitor C4510 are connected across the contacts of relay K4501 and damp out any transients that may be introduced by the switching action of the relay. Resistor R4516 and biasing control R4513 form a voltage divider across the —105 volt-line. Capacitor C4509 is a supply ripple bypass capacitor.

Section V. MODULATOR AUDIO INPUT, METERING, AND FILAMENT CIRCUITS

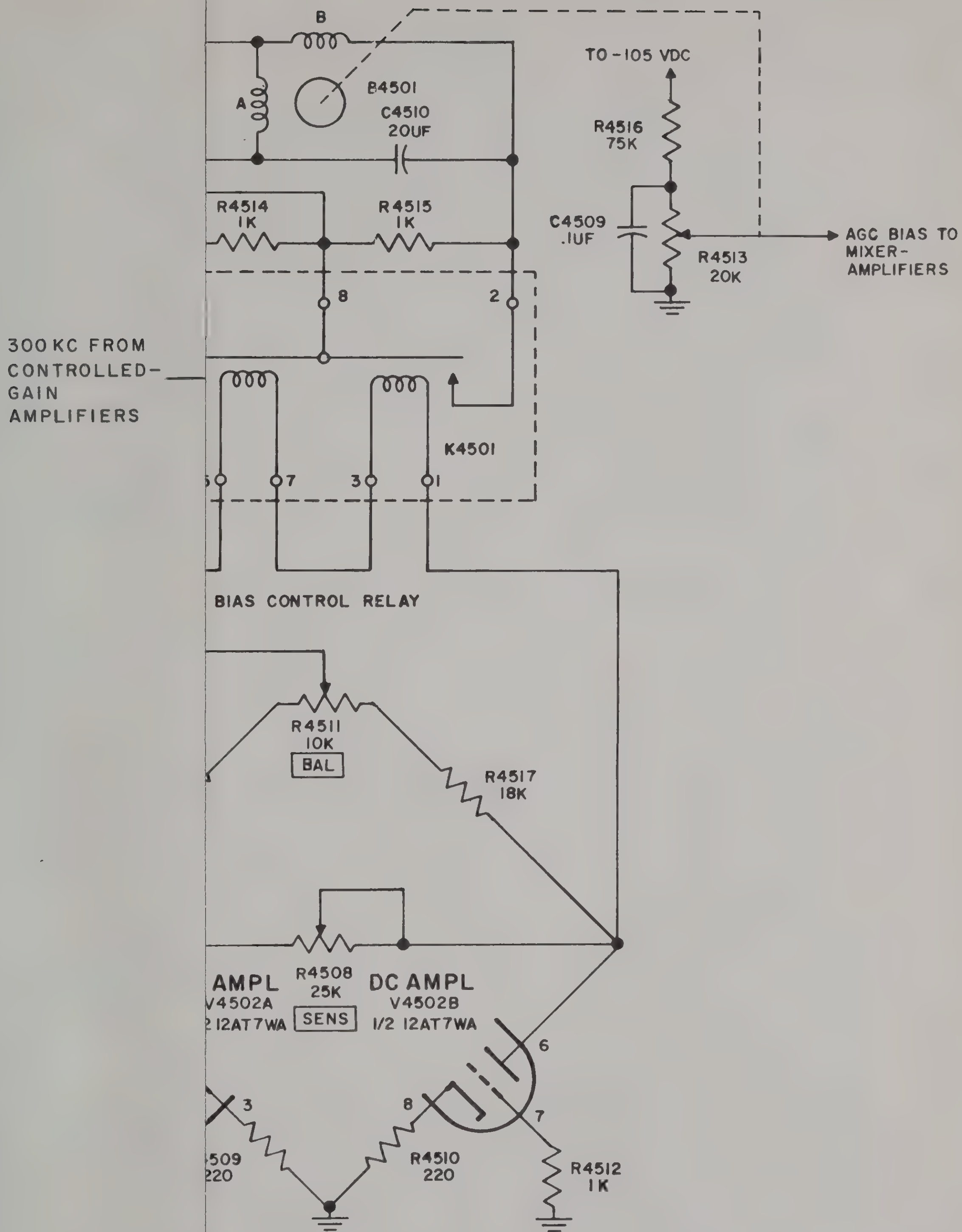
22. Audio Input Circuits
(fig. 21)

a. The audio input circuits to the twin-sideband modulator are identical except for reference symbols. Therefore, only the line 1 audio input will be covered. Line 1 audio input signals are coupled through impedance matching transformer T9601. The output of T9601 is attenuated by the LEVEL control, which is a variable attenuator consisting of R4004, R4005, and R4006. The output of the attenuator is applied to the line 1 section of UPPER SIDEBAND switch S4001 and LOWER SIDEBAND switch S4002. UPPER SIDEBAND switch S4001 and LOWER SIDEBAND switch S4002 are shown in the OFF position. The line 1 audio input is grounded through R4010, contacts 2–12 of S4001, and contacts 12–2 of S4002. No audio from line 1 is applied to the modulator when switch S4001 is in this position.

b. When UPPER SIDEBAND switch S4001 is in the LINE 1 position, the line 1 audio input is routed through contacts 3–2 of S4001, and contacts 7–13 of deenergized sideband interchange relay K4001 through matching pad R4016, R4017, and R4018 to the modulator circuit. The purpose of K4001 is to insure that the lower and upper sidebands have the same relative position with respect to the carrier at the exciter-monitor output regardless of the band switch setting. Since the frequency conversion of the twin sideband signal in the exciter-monitor interchanges the upper and lower sidebands whenever a *difference* frequency is used (as in bands 1 and 3), the sideband interchange relay is automatically energized and the sidebands are interchanged. The output of the matching pad, which matches the audio input circuits to the balanced modulator, is applied to the balanced modulator (par. 12).

23. Audio Metering Circuits
(fig. 21)

a. The two meters, M4001 and M4002, and associated circuits are identical except for reference symbols; therefore, only LINE 1 meter M4001 will be covered. Each meter is used for three separate positions: ALC, 0, and +6. In the ALC position, the meter indicates the approximate amount of alc compression. This function of the meter is covered in paragraph 17*b* and illustrated in figure 19. In the 0 position (contacts 2–8 and 2–4 closed) of S4003, resistor R4007 is placed in series with meter M4001 and the meter provides a normal level indication. In the +6 position (contacts 2–5, 3–8, and 6–7 closed), the meter current is routed through R4007, R4025, R4026, contacts 3–8, meter M4001, contacts



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e. Indicator L4503 and capacitor C4513 decouple both V4501 and V4502 from the +300-volt line. Capacitor C4508 bypasses to ground any RF that may be present on the grid of V4502A. Resistor R4512 is the grid return resistor for V4502B. Resistors R4509 and R4510 are cathode biasing resistors for the two tube sections, and resistors R4518 and R4517 are the individual plate load resistors. Resistor R4508 is a sensitivity control that shunts agc bias control relay K4501 and R4511 is for balancing of the bridge circuit when R4507 is grounded through the BAL contacts of S4501. Resistors R4514, R4515, and capacitor C4510 are connected across the contacts of relay K4501 and damp out any transients that may be introduced by the switching action of the relay. Resistor R4516 and biasing control R4513 form a voltage divider across the —105 volt-line. Capacitor C4509 is a supply ripple bypass capacitor.

Section V. MODULATOR AUDIO INPUT, METERING, AND FILAMENT CIRCUITS

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(fig. 21)

a. The audio input circuits to the twin-sideband modulator are identical except for reference symbols. Therefore, only the line 1 audio input will be covered. Line 1 audio input signals are coupled through impedance matching transformer T9601. The output of T9601 is attenuated by the LEVEL control, which is a variable attenuator consisting of R4004, R4005, and R4006. The output of the attenuator is applied to the line 1 section of UPPER SIDEBAND switch S4001 and LOWER SIDEBAND switch S4002. UPPER SIDEBAND switch S4001 and LOWER SIDEBAND switch S4002 are shown in the OFF position. The line 1 audio input is grounded through R4010, contacts 2–12 of S4001, and contacts 12–2 of S4002. No audio from line 1 is applied to the modulator when switch S4001 is in this position.

b. When UPPER SIDEBAND switch S4001 is in the LINE 1 position, the line 1 audio input is routed through contacts 3–2 of S4001, and contacts 7–13 of deenergized sideband interchange relay K4001 through matching pad R4016, R4017, and R4018 to the modulator circuit. The purpose of K4001 is to insure that the lower and upper sidebands have the same relative position with respect to the carrier at the exciter-monitor output regardless of the band switch setting. Since the frequency conversion of the twin sideband signal in the exciter-monitor interchanges the upper and lower sidebands whenever a *difference* frequency is used (as in bands 1 and 3), the sideband interchange relay is automatically energized and the sidebands are interchanged. The output of the matching pad, which matches the audio input circuits to the balanced modulator, is applied to the balanced modulator (par. 12).

23. Audio Metering Circuits
(fig. 21)

a. The two meters, M4001 and M4002, and associated circuits are identical except for reference symbols; therefore, only LINE 1 meter M4001 will be covered. Each meter is used for three separate positions: ALC, 0, and +6. In the ALC position, the meter indicates the approximate amount of alc compression. This function of the meter is covered in paragraph 17*b* and illustrated in figure 19. In the 0 position (contacts 2–8 and 2–4 closed) of S4003, resistor R4007 is placed in series with meter M4001 and the meter provides a normal level indication. In the +6 position (contacts 2–5, 3–8, and 6–7 closed), the meter current is routed through R4007, R4025, R4026, contacts 3–8, meter M4001, contacts

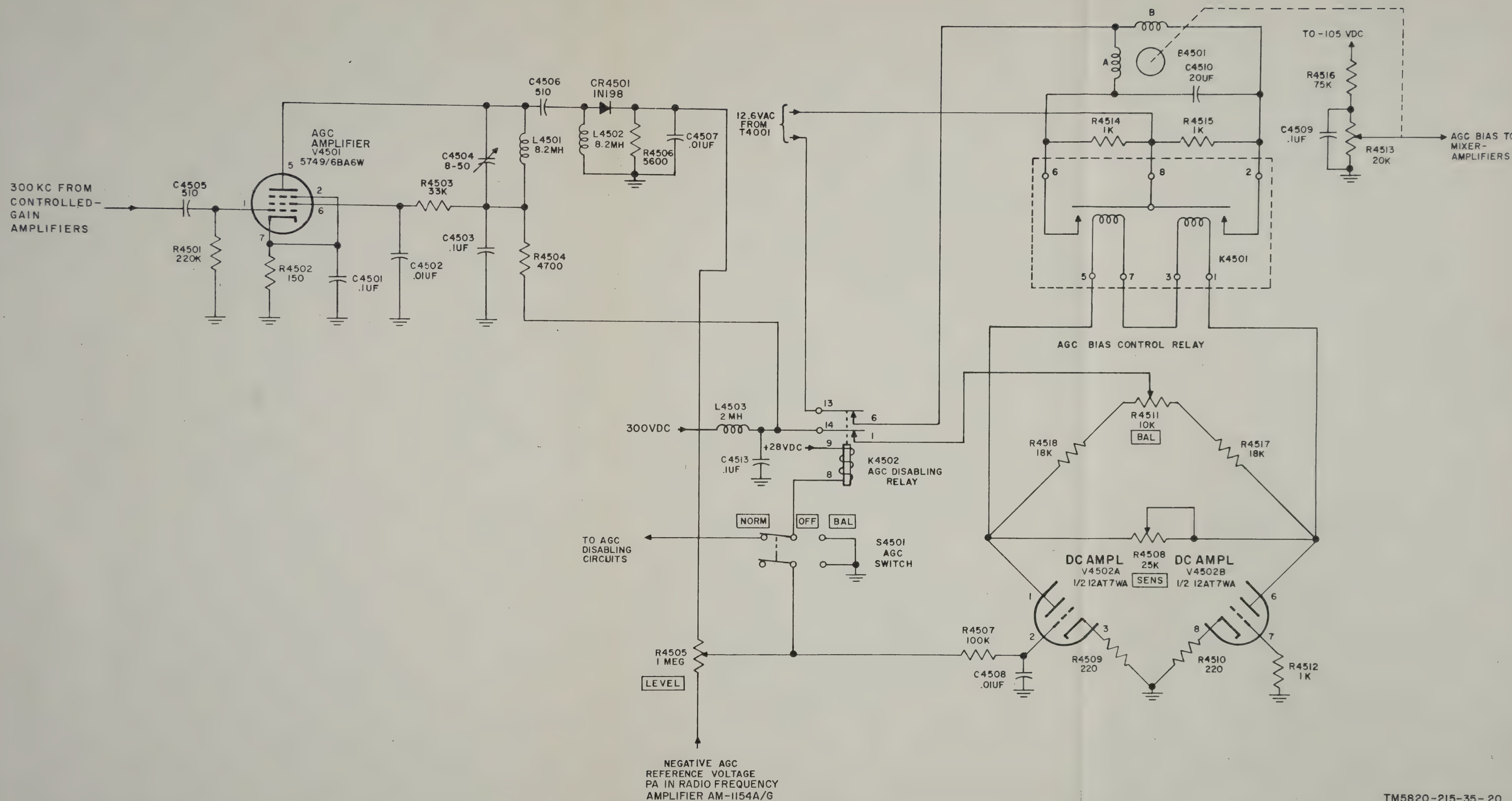
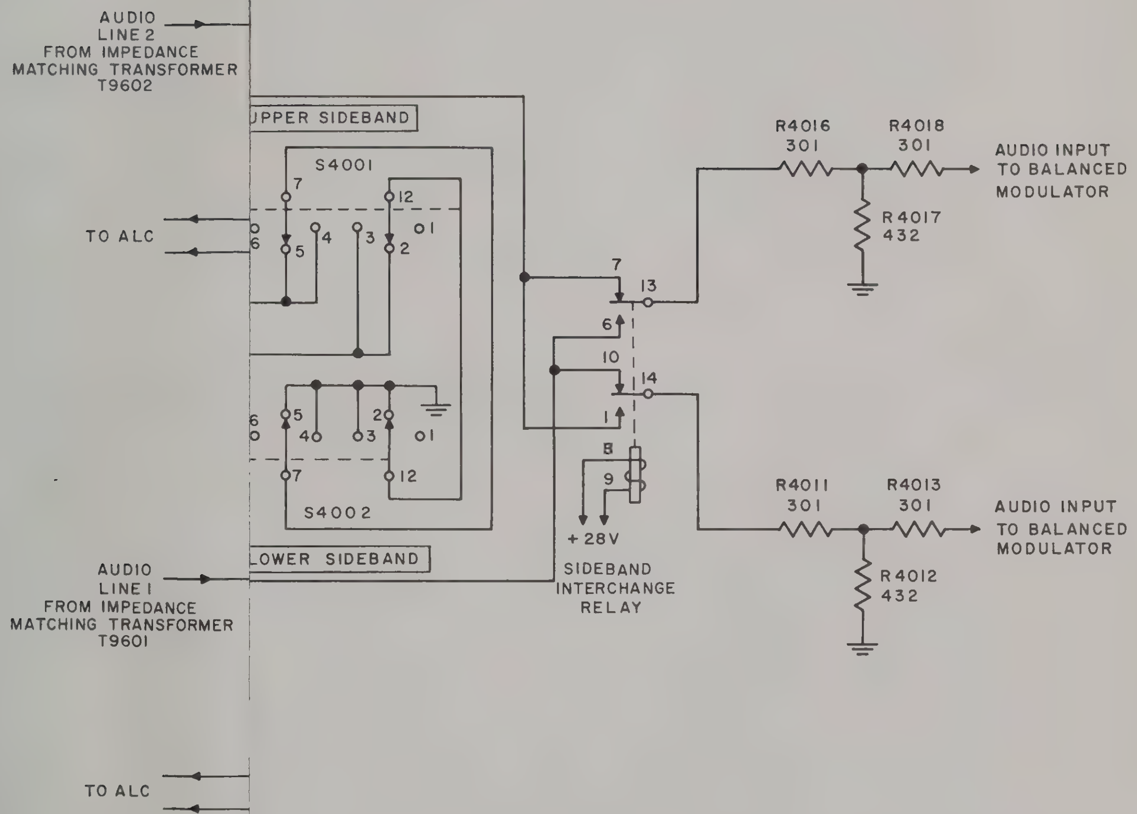


Figure 20. Automatic gain control, schematic diagram.



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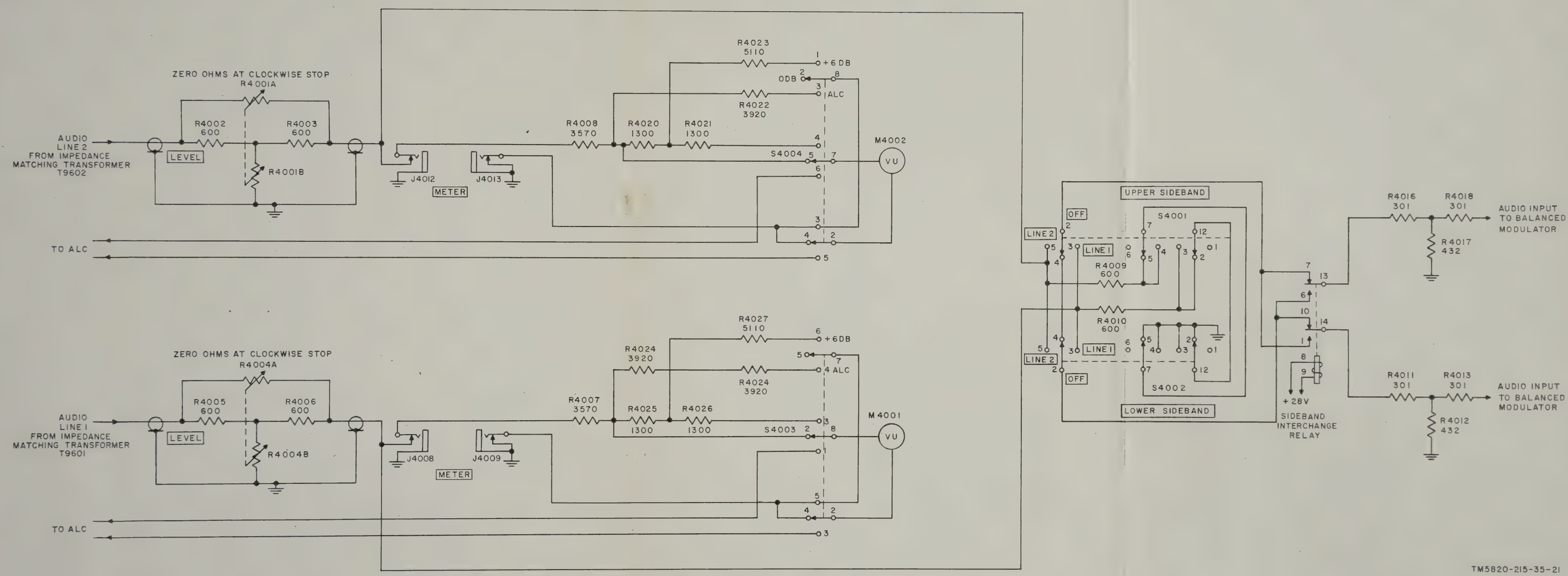


Figure 21. Audio input and metering circuits, schematic diagram.

2–5, and ground. A meter shunt, consisting of R4027 and contacts 6–7 reduces the current flow through the meter. This arrangement reduces the meter sensitivity so that the meter indication is 6 db lower than the actual audio signal level.

b. Test signals may be inserted into METER jacks J4008 and J4009 for direct reading on meter M4001.

24. Modulator Filament Circuit
(fig. 22)

Line voltage of 115-volts ac is applied to the primary of T4001. The secondary is center tapped; 6.3 volts is available from each end of the secondary to ground. The filaments of all the tubes in the tsb modulator are connected in a series-parallel arrangement across the transformer secondary. Capacitors C216, C217, C420, C421, C4117, C4207, C4511, and C4512 maintain the filaments at RF ground potential.

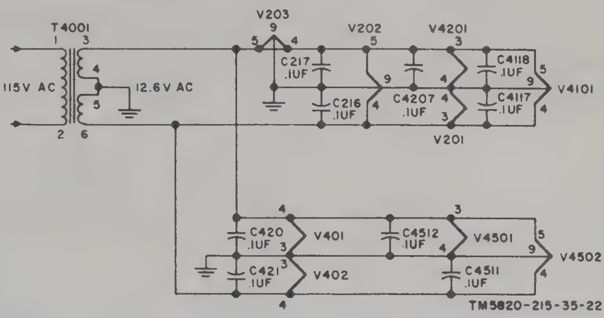


Figure 22. Modulator filament circuit, schematic diagram.

CHAPTER 3

THEORY OF FREQUENCY STANDARD

Section I. CRYSTAL OSCILLATOR AND OVEN CONTROL CIRCUIT

25. One Mc Crystal Oscillator
(fig. 23)

a. The frequency stability of the modulator-oscillator group is largely dependent upon the accuracy of the 1-mc crystal oscillator whose frequency is used as the reference for the stabilized master oscillator (par. 54) and as a source for the four frequency divider subchassis within the frequency standard compartment.

b. The crystal oscillator is an amplitude-controlled, modified Pierce crystal oscillator circuit. A highly stable 1-mc crystal provides plate-to-grid coupling for the oscillator. The temperature of this crystal and three capacitors associated with the oscillator are held constant (within 0.01° C) by the crystal oven (pars. 27 through 31). Small adjustments of the oscillator frequency are made with precision trimmer capacitor C604. The oscillator output is coupled through C608 to the grid of first 1-mc amplifier V602 (par. 26). The amplitude of oscillation is controlled by a negative voltage that is applied to the control grid of V601. This negative voltage is developed in the grid circuit of 1-mc output amplifier V604 (par. 26c), and coupled through R601 in series with the V601 control grid. This is an automatic amplitude control (aac) that limits the power output of the crystal oscillator to a maximum of 0.1 microwatt.

c. Capacitors C605, C606, and C607 are enclosed in the crystal oven. Capacitor C605 has a value which is factory selected because of the difference between crystal units. Resistor R605, together with C605, holds the dc voltage across crystal Y601 to a minimum. Capacitors C606 and C607 are made comparatively large to bypass the plate and grid of the tube to ground, thereby limiting the coupling between the crystal and the tube to a low value. Capacitor C602 is an aac filter, R603 is a plate voltage-dropping resistor, and R604, together with C601 is a plate decoupling network. Resistor R602 is the screen grid voltage-dropping resistor and C603 is the bypass capacitor.

26. Oscillator Amplifier Stages V602 through V604
(fig. 24)

a. The 1-mc output of the crystal oscillator is coupled through C608 to the control grid of first 1-mc amplifier V602. This stage serves as a buffer as well as an RF amplifier. Stages V603 and V604 further amplify the 1-mc signal and apply it to V901 in the 100-kc and 300-kc generator chassis (par. 32).

b. The 1-mc input signal is developed across R606 and amplified by V602. Cathode bias is provided by C609 and R607. Resistor R609 is the plate load; R610 and C611 form a plate decoupling network and R608 and C610 are the screen grid voltage-dropping resistor and the screen bypass capacitor, respectively. Test point TP602 provides access for monitoring the cathode voltage at V602.

c. Second 1-mc amplifier V603 and 1-mc output amplifier V604 are similar to the first 1-mc amplifier described in *b* above. The minor differences are covered below:

(1) Tube V603 uses an inductor instead of a resistor for a plate load. Inductor L601, together with C616 and C617, form a parallel-tuned circuit which serves as the driving source for the aac voltage which is developed by grid rectification in V604.

(2) The cathode bias resistor for V604 is higher in value than that used for V602 and V603. The voltage developed across R618 and C620 prevents grid current from flowing in V604 until the signal from V603 rises above a predetermined amount. When the input signal exceeds this predetermined value, grid current flows and a negative dc voltage

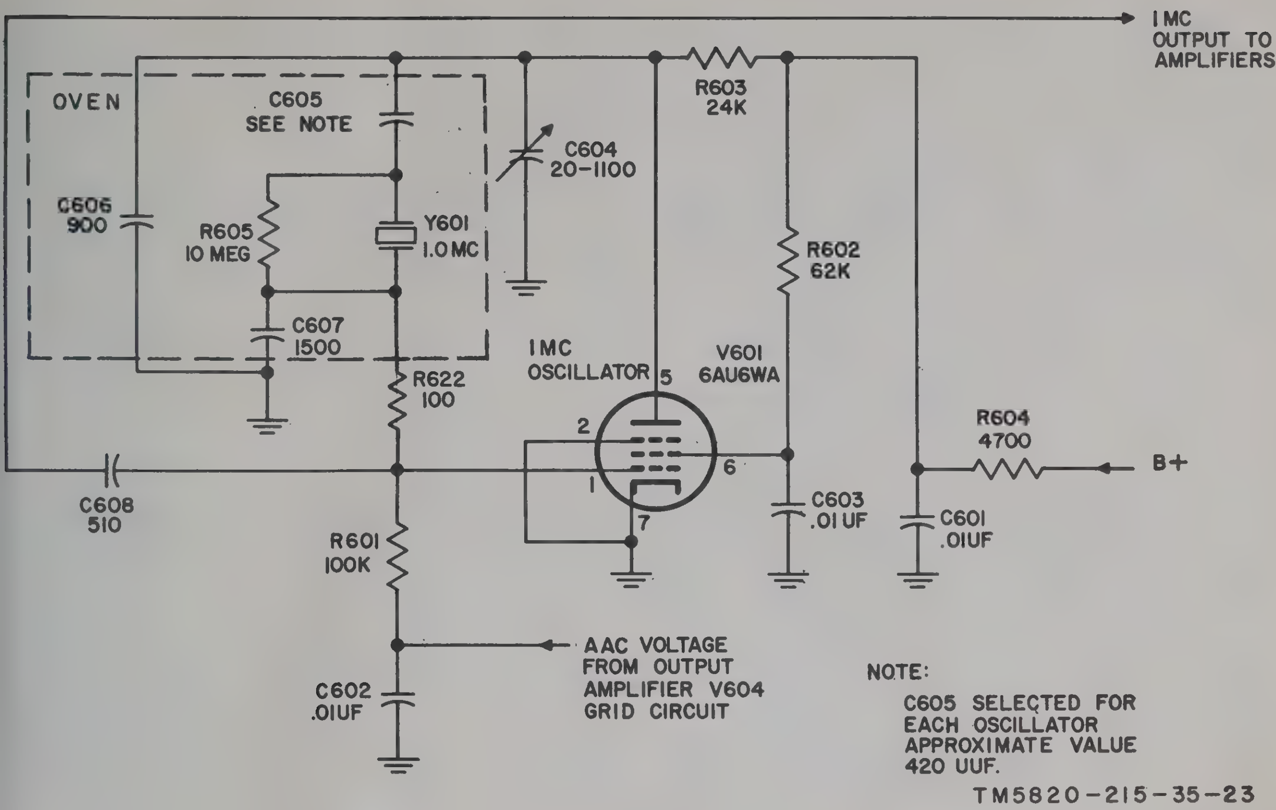


Figure 23. One-mc crystal oscillator, schematic diagram.

is developed across R617 and R616. This voltage is proportional to the 1-mc driving signal amplitude and serves as a delayed aac voltage that is coupled through R615 to 1-mc oscillator V601. A portion of the aac voltage is coupled to M701 for metering purposes (par. 46).

27. Oven Control Circuit Block Diagram
(fig. 25)

a. To prevent frequency variations with temperature changes, crystal Y1 is housed in an oven whose temperature change is limited to ±0.01° C. A three-stage oscillator-amplifier feeds a resistance bridge which serves as the oven heater. This arrangement senses a temperature change in the oven and controls the amount of power delivered to the heater. The crystal is housed in an aluminum cylinder around which the heater is wound. Because of the high heat conductivity of aluminum and because the crystal is completely surrounded by aluminum, the temperature of the crystal is nearly identical with that of the aluminum enclosure.

b. Amplifiers V605, V606, V607, and V608 function together as a multistage oscillator, receiving positive feedback through transformer T601 and an unbalance in the resistance bridge. The output circuit of first amplifier V605 is tuned to approximately 2.5 kc. Feedback voltage is coupled from the resistance bridge to V605. The 2.5-kc output of V605 is coupled to V606A and then through phase splitter V606B to push-pull output amplifiers V607 and V608. The output of the push-pull stage (output amplifiers) is coupled through transformer T601 and applied across resistance bridge HR601.

c. The resistance bridge performs two functions. It provides the heat for the oven and functions as part of the oscillator feedback loop. When the bridge comes into balance, as the temperature approaches the desired value, the amount of feedback is reduced until it is just sufficient to sustain oscillations. Protective thermostat S601 closes and shorts the bridge when the oven temperature exceeds 176° F. (80° C.).

28. Oven Amplifiers V605 and V606A
(fig. 26)

a. First Amplifier V605. A 2.5-kc signal from the bridge circuit (par. 31) is applied through R626 to the control grid of V605. The amplitude of this signal is controlled by the resistance of the arms within

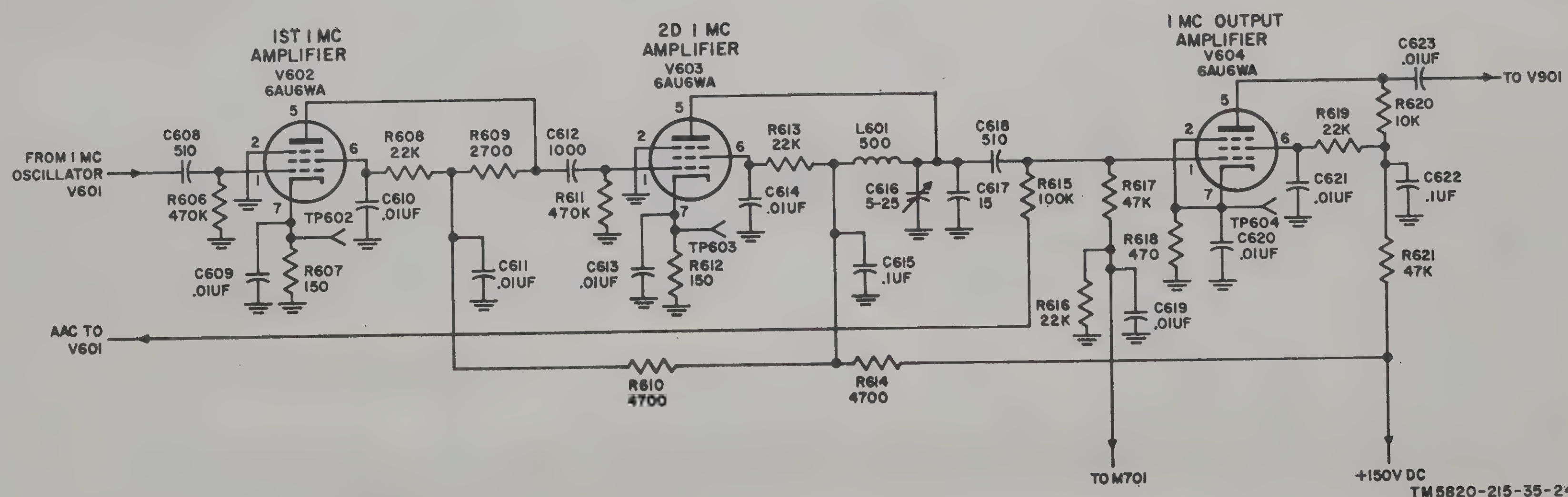


Figure 24. 1-mc amplifier stages, schematic diagram.

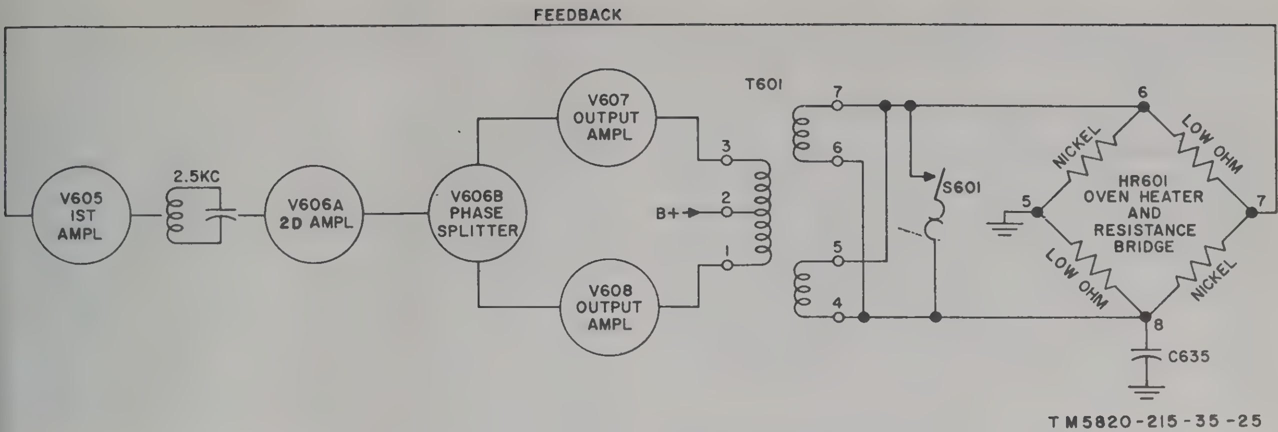


Figure 25. Oven control oscillator, block diagram.

the bridge. The input voltage to V605 is developed across R627, amplified and applied to 2.5-kc tuned circuit L603 and C627. The voltage across this tuned circuit is coupled through C629 to the grid of second oven amplifier V606A. Plate decoupling is provided by R645 and C628. The screen grid voltage-dropping resistor is R628 and C626 is the screen grid bypass capacitor.

b. Second Amplifier V606A. The 2.5-kc input signal from V605 is coupled through C629 and R629 to the grid of V606A. The input signal is developed across R630, amplified by V606A, and developed across plate load resistor R632. The output of this stage is coupled through C630 to phase splitter V606B. Cathode bias is provided by R631. Plate decoupling is provided by R633 and C632. Test point TP605 provides access for voltage measurement at the cathode of V606A.

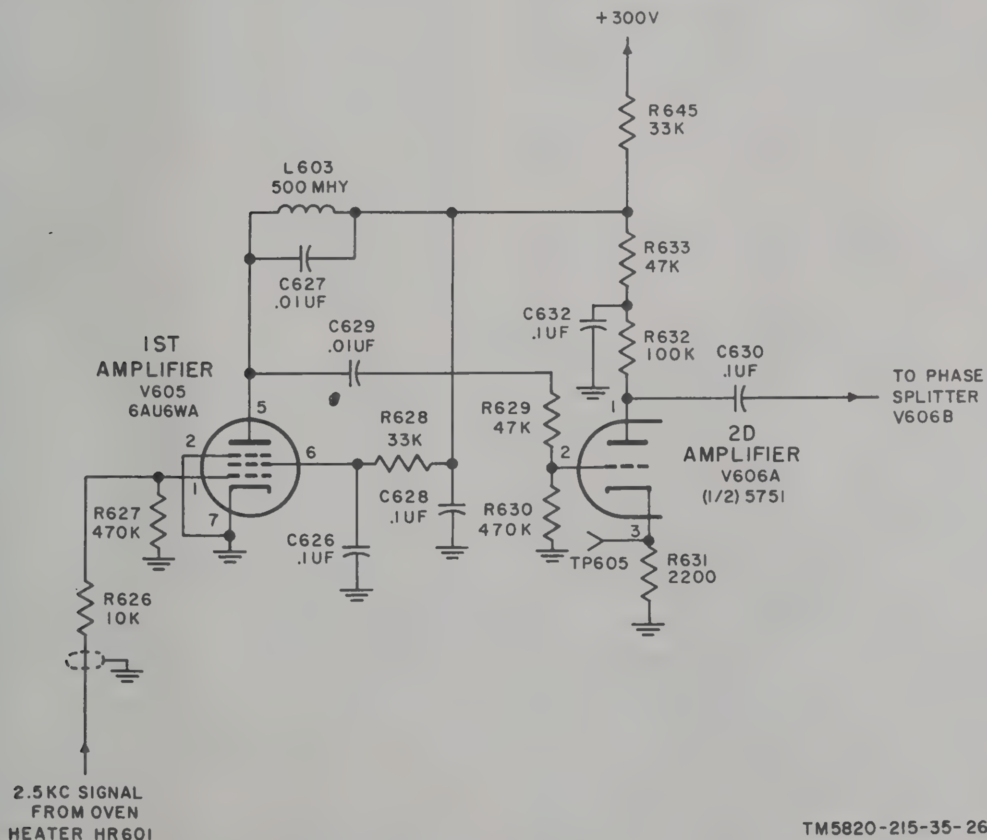


Figure 26. Oven amplifiers V605 and V606A, schematic diagram.

29. Phase Splitter V606B

(fig. 27)

a. The 2.5-kc amplitude-conrtolled signal from V606A is coupled through C630 and applied to the grid of V606B. The 2.5-kc voltage is developed across resistors R634 and R635. Tube V606B is a split-load amplifier. Equal value load resistors in the cathode and plate circuits develop two, equal-amplitude, out-of-phase voltages that are applied to output amplifiers V607 and V608 connected in push-pull.

b. Resistor R634 is connected between the grid and cathode of V606B; therefore, the 2.5-kc voltage developed between cathode and ground does not cause excessive degeneration of the output of V606B. The 2.5-kc voltage that is developed across cathode load resistor R635 is coupled through C634 and applied to V608. A voltage is also developed in the plate circuit across R636. This voltage is coupled through C633 to V607.

c. Bias voltage for V606B is furnished by grid leak action of R634 and C631. Test point TP606 provides access for signal measurement at the cathode of V606B. The plate is decoupled by R633 and C632.

30. Output Amplifiers V607 and V608

(fig. 27)

a. Out-of-phase 2.5-kc voltages from V606B are applied to the grids of output amplifiers V607 and V608. These two tubes are connected in a push-pull circuit with the plates connected to the center-tapped primary of T601. Transformer T601 couples the 2.5-kc output power to bridge circuit HR601. Resistor R641 is the common cathode resistor and R642 is the common screen grid voltage-dropping resistor. Because of the push-pull arrangement, no cathode bypass or screen grid capacitors are needed. The plate is decoupled from the power supply by R643 and C639.

b. A portion of the 2.5-kc output voltage from the primary of T601 is coupled through R644, C640, and developed across R646. This voltage is applied to meter M701 through S701 (par. 46*a*).

31. Crystal Oven Heater and Control Circuit

(fig. 27)

a. The 2.5-kc output from the push-pull stage (par. 30) appears across the secondary of T601 and is applied across terminals 6 and 8 of heater bridge circuit HR601. Two arms of the bridge circuit are made of nickel wire and the other two are made of low ohm wire. When the oven heater is at the desired

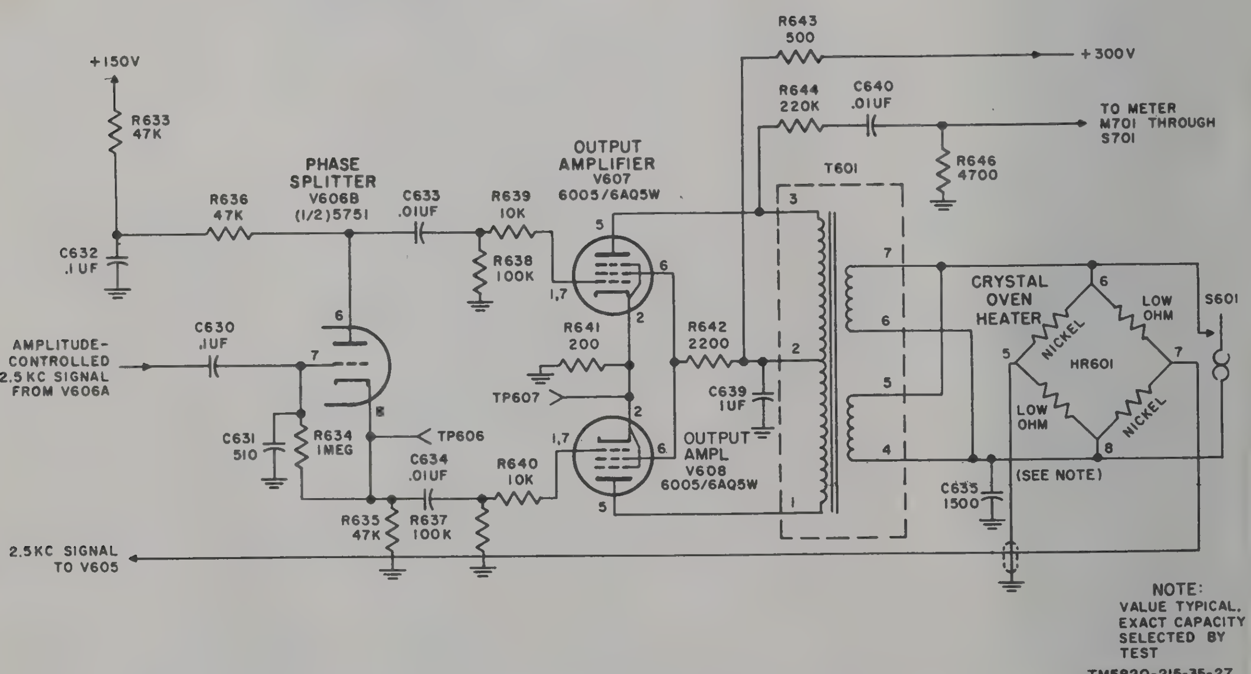


Figure 27. Oven oscillator output amplifiers and oven heater circuit, schematic diagram.

oven temperature, all four sections of the bridge circuit have the same ohmic value and no voltage is developed between terminals 5 and 7 of HR601. When this condition exists, no voltage is coupled back to first amplifier V605. If the oven temperature is low, the nickel wire has less resistance than the low ohm wire, and a voltage difference is developed between terminals 5 and 7 of the bridge circuit. This voltage is the 2.5-kc signal that is fed back to V605. The amplitude of this feedback voltage is determined by the degree of bridge unbalance.

b. When the oven control circuit is operating normally, the dissipation (in the form of heat) of the 2.5-kc output power within the bridge is just equal to the gain of the amplifier system (V605 through V608) and a steady-state condition is obtained. This maintains the oven at a temperature just below the true balance temperature of the bridge. Thermal switch S601 shorts the secondary of T601 whenever the temperature of the oven exceeds 176° F. (80° C.).

Section II. 100-KC AND 300-KC GENERATOR

32. Mixer V901

(fig. 28)

a. The 100-kc and 300-kc generator subchassis consists of a mixer and two multiplier stages that receive the 1-mc signal from V604 (par. 26*c*) and generate 100- and 300-kc signals. The 1-mc signal is coupled through C902, developed across R902, and applied to the injector grid (pin 7) of mixer V901. When the circuit is first energized, noise energy from the 900-kc tuned circuit (C915 and L902) results in the application of a 900-kc component through C912 to the control grid of the mixer tube; the 900-kc voltage is developed across R906. The two inputs mix and produce a difference frequency of 100 kc that develops across 100-kc tuned circuit L901, C907, C908, and C909. The 100-kc output is coupled through C906 and applied to the control grid of first frequency tripler V902B. A portion of the 100-kc output is also applied to the 25-kc and 250-kc generator subchassis (par. 37).

b. Cathode bias for V901 is provided by R903 and C903. Capacitor C904, together with C912, forms a capacitance voltage divider that applies the desired amount of 900-kc signal to the control grid of V901. Plate decoupling for the mixer is provided by R904 and C910.

c. The 900-kc signal applied to pin 1 of V901 causes grid current to flow through R906. A portion of the voltage developed across R906 is coupled through R901 to meter M701 (par. 46*c*). The meter indicates the level of the 900-kc signal.

33. First Frequency Tripler V902B

(fig. 28)

The 100-kc signal from mixer V901 is coupled through C906 and developed across grid resistor R908. The plate circuit of V902B, consisting of L903, C916, C924, C919, and C923, is tuned to the third harmonic of the 100-kc input frequency. The 300-kc signal that is developed across this tuned circuit is applied through C913 to the second frequency tripler V902A. A portion of the 300-kc output is also applied to the exciter-monitor chassis through J902. Plate decoupling from the power supply is provided by C917 and R910. The 100-kc signal applied to pin 7 of V902 causes grid current to flow through R908. The voltage developed across R908 is coupled through R912 to meter M701 (par. 46*e*).

34. Second Frequency Tripler V902A

(fig. 28)

Second frequency tripler V902A is similar to the first frequency tripler (par. 33). The 300-kc input is coupled through C913 and developed across grid resistor R907. The plate circuit of V902A is tuned to the third harmonic of the 300-kc input frequency, and the resultant 900-kc output is applied to mixer V901 through C912. Inductor L902 and capacitor C915 form a tuned circuit at the plate of V902A. Resistor R909 and capacitors C914 and C918 provide plate decoupling from the 300-volt supply. The 300-kc signal applied to pin 2 of V902 causes grid current to flow through R907. The voltage developed across R907 is coupled through R914 to meter M701 (par. 46*d*).

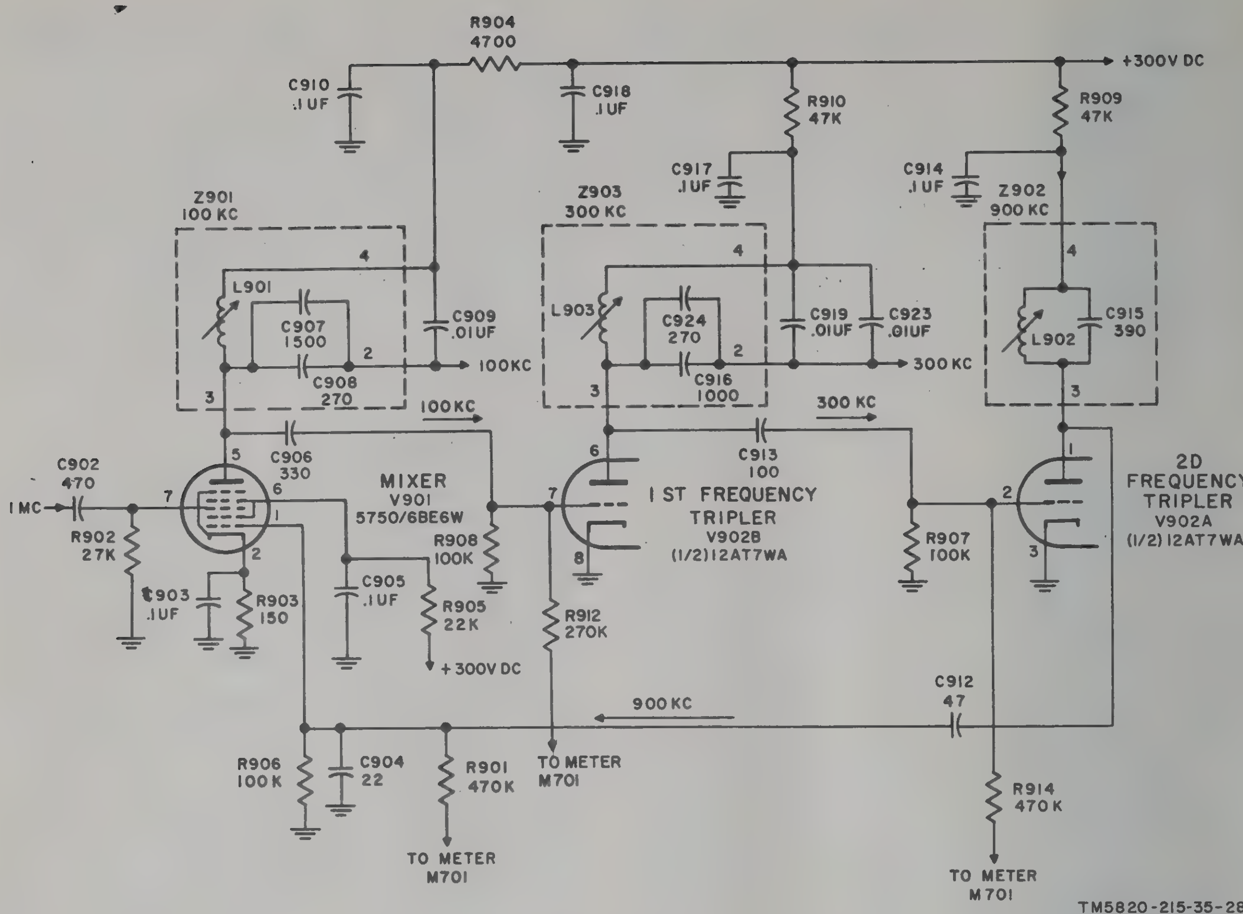


Figure 28. 100-kc and 300-kc generator, schematic diagram.

Section III. 250-KC AND 25-KC GENERATOR

35. 100-Kc Amplifier V503

(fig. 29)

a. The 100-kc amplifier, V503, is located within the 250-kc and 25-kc generator chassis; however, it plays no active part in the development of either frequency. The 100-kc amplifier serves as a buffer amplifier between the source of the 100-kc signal (V901, par. 32) and the tsb modulator.

b. The 100-kc signal is coupled through C517 and applied across voltage divider R525 and R510. The voltage across R510 is amplified by V503 and developed across 100-kc tuned circuit L504, C515, and C516. The tuned circuit output is coupled through C518 to another tuned circuit consisting of C519, C520, C523, and L505. The 100-kc voltage across C523 is coupled to the tsb modulator (par. 9*a*) and to meter M701 (par. 46*f*).

c. The 100 KC LEVEL cantrol, R701, determines the bias on V503 and the level of the 100-kc output. Inductor L511 is a series bias voltage filter and R511 establishes minimum bias. Capacitor C521 reduces degeneration in the cathode circuit and bypasses any noise that may be injected by test equipment inserted at TP503. The screen grid voltage-dropping resistor is R513 and the screen grid bypass capacitor is C522. Plate decoupling from the power supply is provided by R512 and C514.

36. Buffer Amplifier V501

(fig. 30)

This stage amplifies and couples the 100-kc input from mixer V901 (par. 32) to mixer-multiplier V502. The 100-kc voltage is coupled through C501 and applied across grid resistor R501. Tube V501 amplifies this voltage and the output appears across the plate

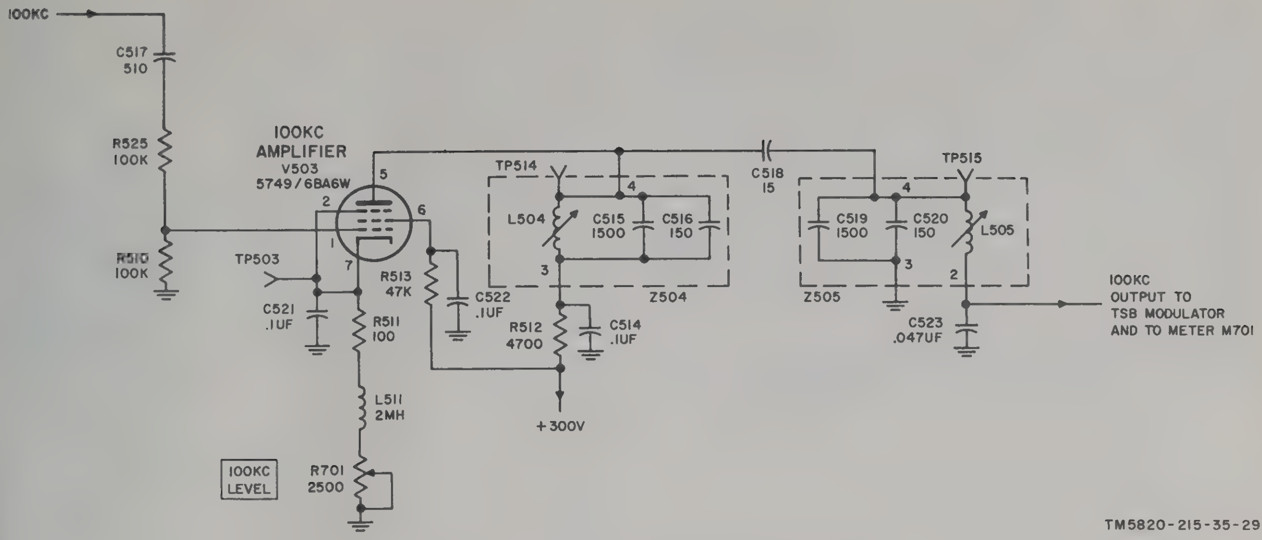


Figure 29. 100-kc amplifier, schematic diagram.

load consisting of L508, C542, C504, and C505. Resistor R528 lowers the Q of the plate load to the desired value. The output of this stage is applied to Z501. Cathode bias is provided by R502 and C502. Resistor R503 is the screen grid voltage-dropping resistor and C506 is the screen grid bypass. The plate is decoupled by R504 and C503. Test point TP504 provides easy access for cathode voltage measurements.

37. Mixer-Multiplier V502

(fig. 31)

a. The amplified 100-kc signal from buffer amplifier V501 is applied to mixer-multiplier V502. This stage produces frequencies of 250 kc and 25 kc by frequency multiplying and mixing actions.

b. The 100-kc input signal that appears across resistor R522 is applied through the primary of Z501 to the control grid of V502A. Upon circuit starting, noise energy from the 75-kc tuned circuit (winding 3–4 of Z501, C510, and C533) results in some 75-kc energy being induced into winding 1 and 2 of Z501. The 100-kc input from V501 mixes with the 75 kc in V502A to produce a 25-kc output signal that develops across Z503; tuned circuit Z502 (tuned to 250 kc) offers negligible impedance to the 25-kc signal. Tuned circuit Z503 is resonant to 25 kc and develops a strong 25-kc signal across its terminals. The 25-kc signal is applied across grid resistor R509 and applied to frequency tripler V502B. It is also coupled through C513 to the 5-kc and 1-kc generator (par. 40). The plate circuit of V502B is tuned to the third harmonic of 25-kc which is the 75-kc frequency across winding 3 and 4 of Z501. This 75-kc feedback voltage implements the original 75-kc noise energy that caused this circuit to start functioning.

c. Both sections of V502 produce injection frequencies that are rich in harmonic energy. The output of V502B contains the second harmonic of 75

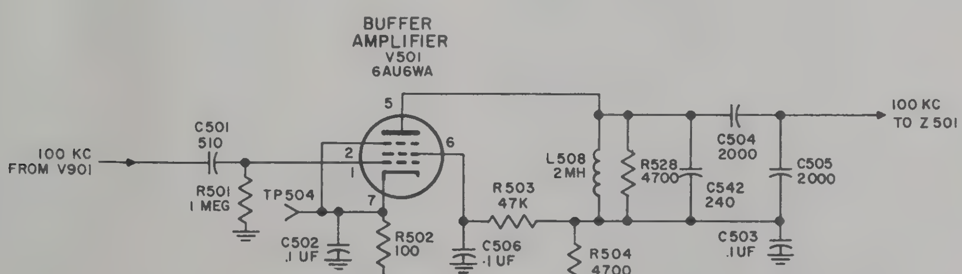


Figure 30. 100-kc buffer amplifier V501, schematic diagram.

kc. The 150-kc (75 kc × 2) signal is coupled through Z501 and is also mixed with the 100-kc input signal in V502A. Tank circuit Z502 is tuned to the sum of these two frequencies (150 kc + 100 kc), thereby producing a 250-kc signal that is fed to 250-kc amplifier V504. The 75-kc and 100-kc signals at the grid of V502A cause grid current to flow through R522. A portion of the voltage developed across R522 is coupled through R505 to meter M701 (par. 46*h*).

d. Cathode bias for V502A is furnished by R508 and C512. Plate decoupling for V502A is furnished by R507 and C509. Plate decoupling for V502B is provided by R506 and C508.

38. 250-Kc Amplifier V504
(fig. 32)

The 250-kc input signal from Z502 is amplified by V504 and applied to the exciter-monitor compartment and to meter M701 (par. 46*g*). Except for reference symbols and component values, this stage is identical with 100-kc amplifier V503. Refer to paragraph 35 for the functions of the components within this stage.

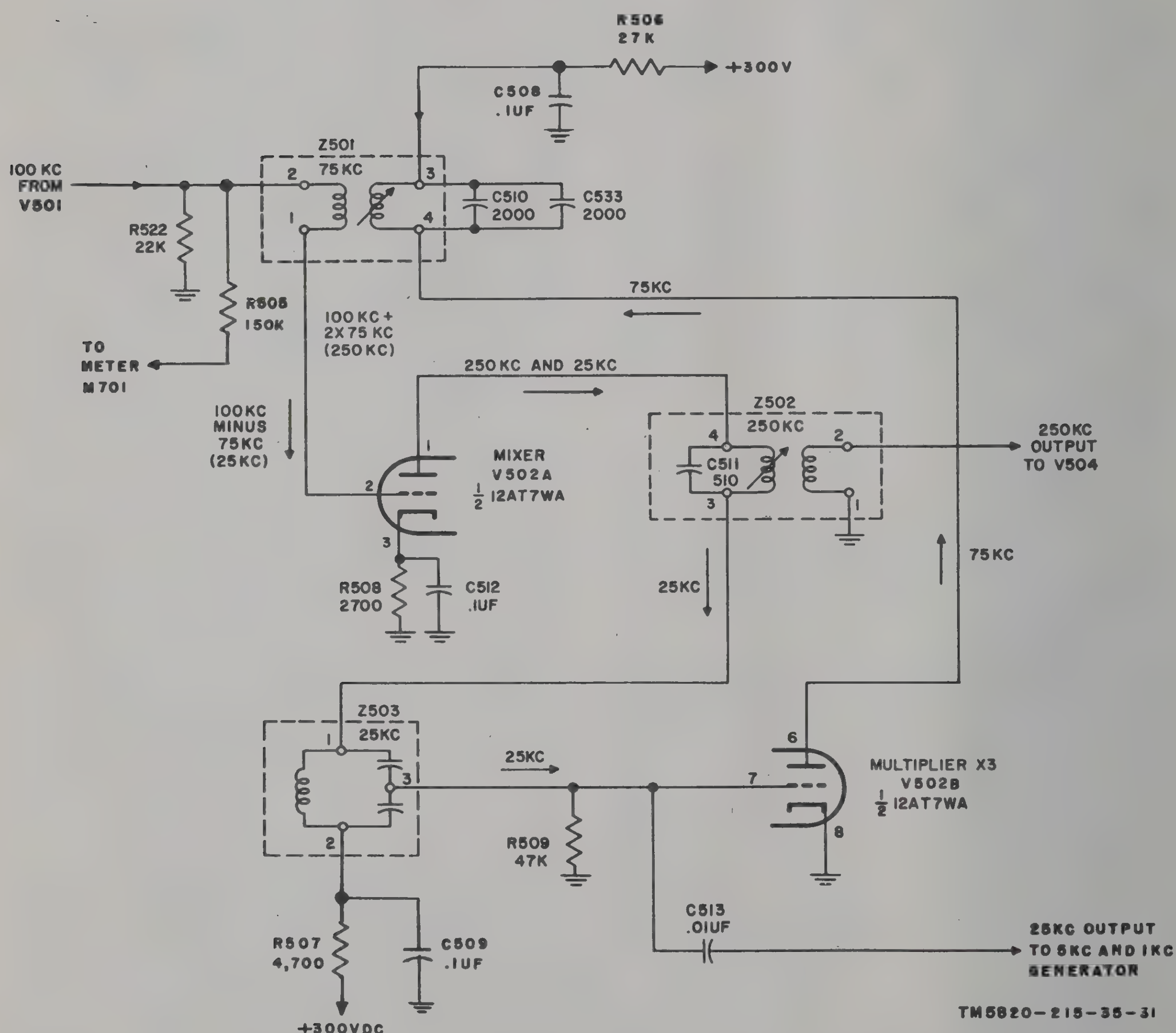


Figure 31. Mixer-multiplier V502, schematic diagram.

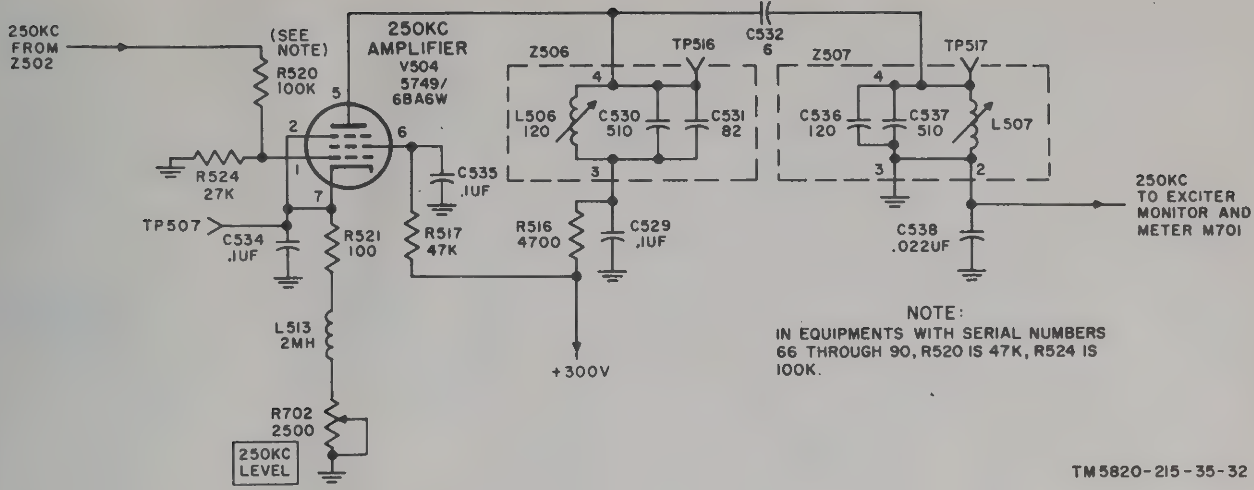


Figure 32. 250-kc amplifier V504, schematic diagram.

Section IV. 5-KC AND 1-KC GENERATOR

39. General

The 5-kc and 1-kc generator chassis consists of two similar mixer-multiplier circuits. They are identical in operation except for the frequencies involved. Figure 33 is a schematic diagram of the 5-kc generator; figure 34 is a schematic diagram of the 1-kc generator.

40. Mixer Doubler V1301

(fig. 33)

a. The 25-kc signal from mixer-multiplier V502 (par. 37) appears across resistor R1311 and is applied through winding 3–4 of Z1302 to the control grid of mixer V1301A. Upon circuit starting, noise energy from the 20-kc tuned circuit (terminals 1 and 2 of Z1302) results in the induction of 20-kc energy into winding 3–4 of Z1302. The 25-kc input mixes with the 20-kc component and produces a difference frequency of 5 kc that is developed across the 5-kc tuned circuit of Z1303 in the plate circuit of V1301A.

b. The 5-kc signal across winding 1 and 2 of Z1303 is induced into the secondary winding (3–5). This signal, coupled through J1303, serves as the 5-kc source for the exciter-monitor compartment. The 5-kc signal is also coupled through C1312 to 1-kc generator V1302B (par. 41). Winding 3–5 of Z1303 is connected with CR1303A and CR1303B in a full-wave rectifier circuit that functions as a harmonic generator. The 5-kc frequency is doubled by the full-wave action of the rectifier circuit. The 10-kc signal appears across resistor R1315 and is applied to the grid of doubler V1301B. Grid current that flows through R1315 furnishes a voltage to meter M701 through R1310 (par. 46*i*). The plate circuit of V1301B is tuned to the second harmonic of the input frequency. The 20-kc signal is developed across winding 1–2 or Z1302. This 20-kc voltage implements the original 20-kc noise energy that caused this regenerative circuit to begin functioning.

c. Cathode bias for V1301A is provided by R1314 and C1309. Plate decoupling for V1301A is provided by R1313 and C1318. Plate decoupling for V1301B is provided by R1312 and C1319. Jack J1302 provides a 5-kc output for test purposes.

41. Mixer Doubler V1302

(fig. 34)

The 5-kc input signal from mixer-doubler V1301 is applied to mixer V1302A. This stage generates the 1-kc signal that is coupled through J1305 to the 4.5- and 1.5-kc generator (par. 42 through 45). A portion of the 1-kc signal across the secondary of Z1305 is coupled through J1304 to the spectrum detent subchassis in the exciter-monitor compartment. The voltage across R1318 due to grid current flow is coupled through R1321 to meter M701 (par. 46*j*). Except for reference symbols, component values, and frequencies involved, this stage is identical with the 5-kc generator (fig. 33). Refer to paragraph 40 for the functions of the individual components within this stage.

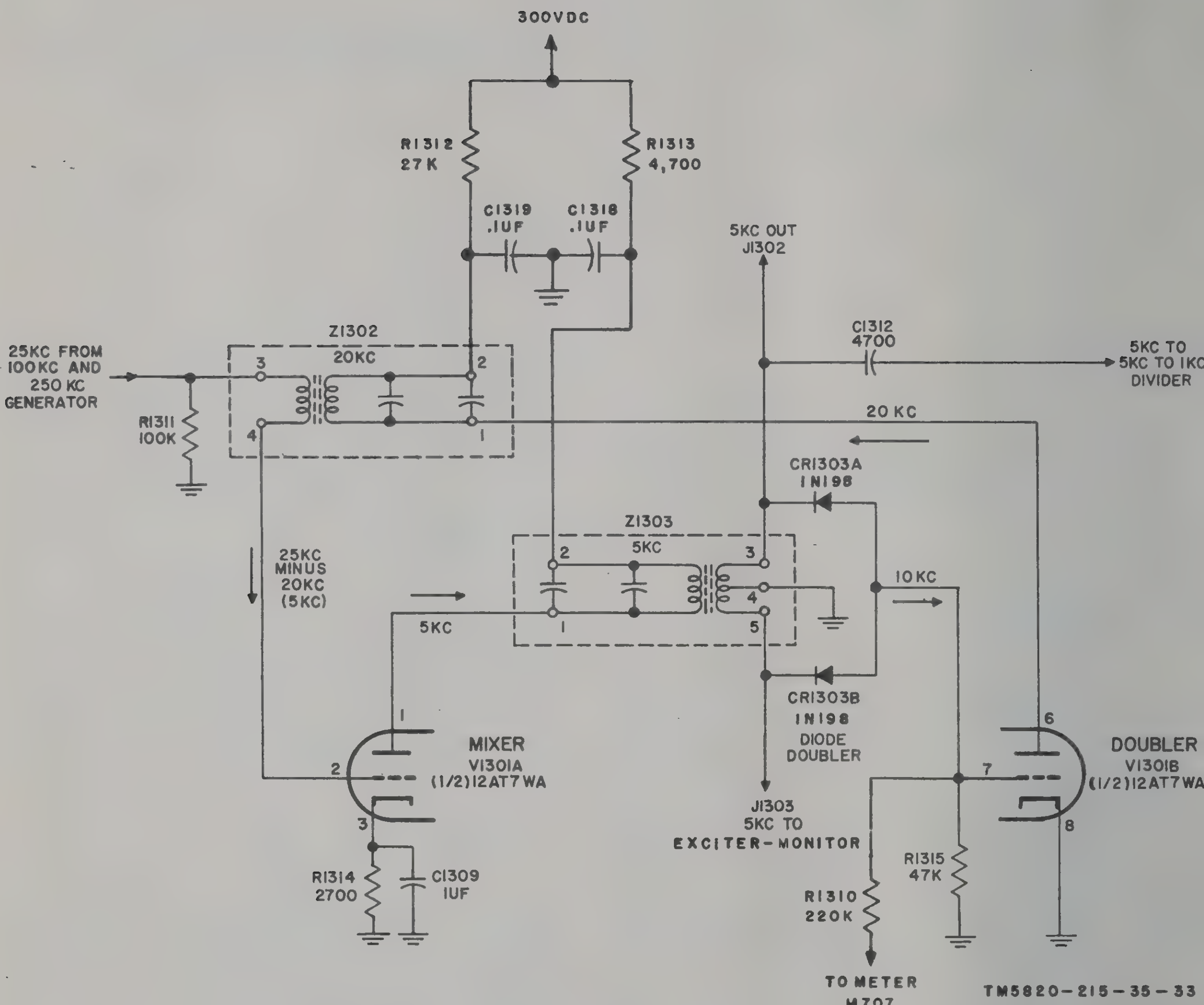


Figure 33. 5-kc generator stage, schematic diagram.

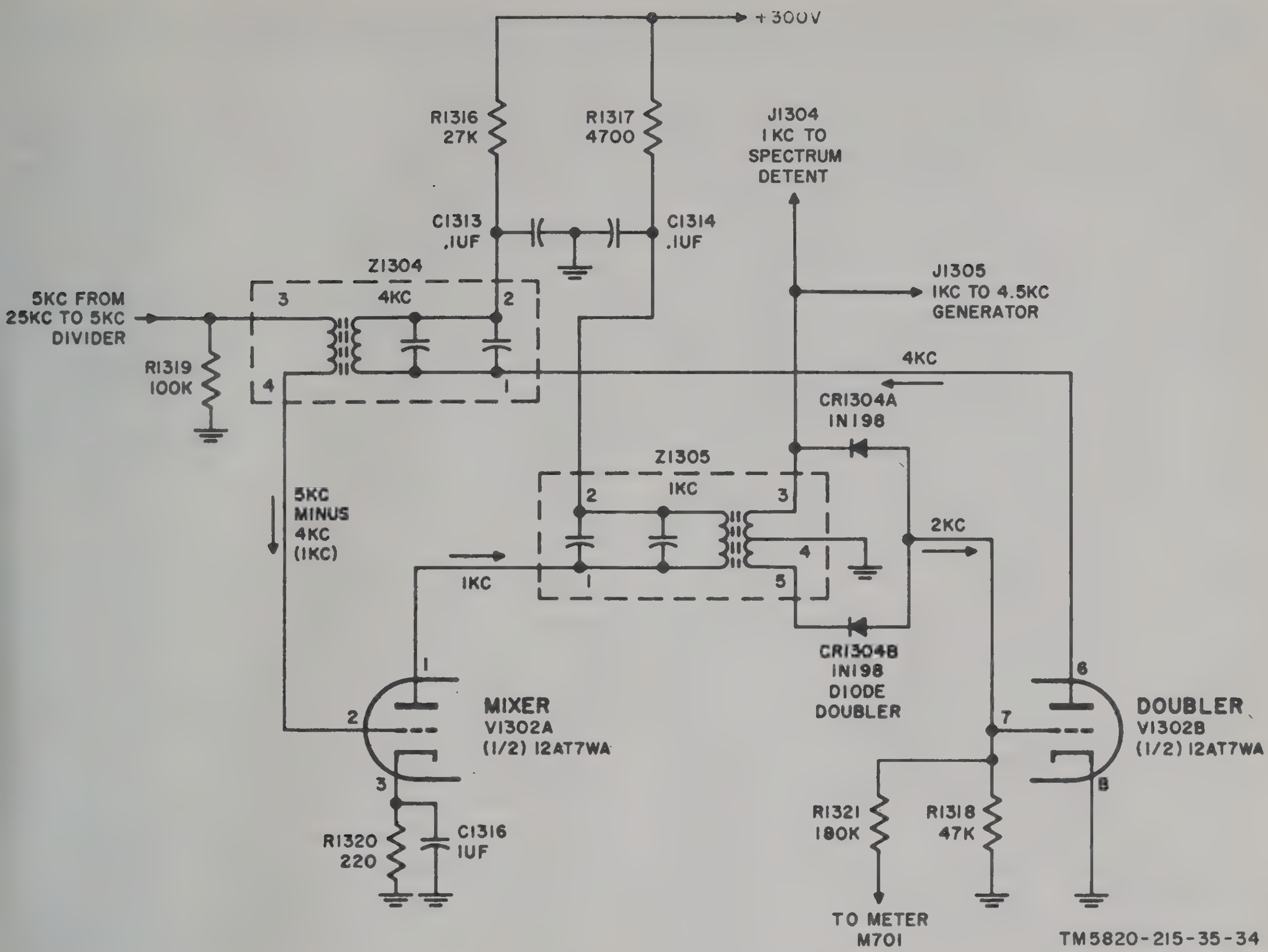


Figure 34. One-kc generator, schematic diagram.

Section V. 4.5-KC AND 1.5-KC GENERATOR

42. General

The 4.5-kc and 1.5-kc generator contains a buffer stage, a 1-kc to 0.5-kc frequency divider, and two frequency triplers. The 1-kc signal from mixer-doubler V1302 is divided to 0.5 kc and then multiplied to produce 1.5- and 4.5-kc signals.

43. Buffer V4701
(fig. 35)

Buffer stage V4701 isolates the preceding 1-kc generator stage from frequency divider V4702. The 1-kc input signal from the 1-kc generator is coupled through C4701 and applied across grid resistor R4703 and to the control grid of V4701. Tube V4701 amplifies the 1-kc input; the amplified signal develops across plate load R4706. The output of V4701 is coupled through C4704 to the following stage. Resistor R4704 is the screen grid voltage-dropping resistor and C4702 is the screen grid bypass capacitor. Plate decoupling is provided by R4705 and C4703.

44. Frequency Divider V4702
(fig. 35)

a. The 1-kc output from V4701 is coupled through C4704 to the cathode of V4702A and then through C4706 to the grid of V4702B. The two currents flowing through the tube as a result of the 1-kc input voltage are 180° out of phase and cancellation at this frequency takes place in the plate circuit. Upon circuit starting, noise energy from 0.5-kc tuned circuit Z4701 is coupled through C4707 to the cathode of V4702B and then through C4705 to the control grid of V4702A. This 0.5-kc energy also produces

tube currents that are 180° out of phase, resulting in cancellation in the plate circuit.

b. The 1-kc input from V4701 and the 0.5-kc input from Z4701 are mixed in V4702. The mixing action produces sum and difference frequencies. The sum frequency (1.5 kc) is rejected by Z4701 while the difference frequency (0.5 kc) is developed across the tuned circuit, implementing the original noise energy that caused this regenerative circuit to begin functioning. Note that both input frequencies appear in opposite phase at the tube plates and tend to cancel, while the 0.5-kc *difference* frequency appears across Z4701. Since this 0.5-kc signal is derived from the 1-kc input signal which, in turn, was derived from the 1-mc crystal oscillator, it has the same accuracy and stability as the crystal oscillator. Capacitor C4709 couples the 0.5-kc output to the 0.5-kc to 4.5-kc multiplier.

c. Resistors R4708 and R4712 are grid parasitic oscillation suppressors, and R4713 and C4708 provide plate decoupling for both halves of V4702. Resistors R4707 and R4711 are grid resistors for the two tube halves. Resistors R4709 and R4710 provide cathode bias for V4702A and V4702B, respectively. The cathode resistors are also fed by the two mixing frequencies to establish opposite phasing for cancellation of these frequencies in the V4702 plate circuit (*a* above).

45. Frequency Triplers V4703A and V4703B (fig. 36)

a. Tube V4703 is connected as two tripler stages in cascade. The 0.5-kc input is applied across R4715 and coupled through parasitic oscillation suppressor R4714 to the grid of V4703A. The plate circuit of this tube is tuned by the primary of tuned circuit Z4702 to the third harmonic of 0.5 kc. The 1.5-kc output that is developed across Z4702 is induced into the secondary and coupled to the second frequency tripler through C4712 and parasitic oscillation suppressor R4719. The 1.5-kc secondary voltage is directly coupled to J4703 for test purposes. Plate decoupling for V4703A is provided by R4717 and C4711.

b. The 1.5-kc signal coupled through C4712 is applied across R4718, R4716, and R4713 in series. Grid current flow develops a voltage across R4723 which is applied to meter M701 (par. 46*k*). Resistor R4716 and capaictor C4710 form a decoupling network that keeps variations out of the meter circuit. The plate circuit of V4703B is tuned to the third harmonic of the signal applied to the grid. A 4.5-kc signal is developed across the primary of Z4703. The 4.5-kc signal is coupled both by induction and by capacitor C4714 to the secondary of Z4703. The 4.5 kc is routed through R4724 and through J4702

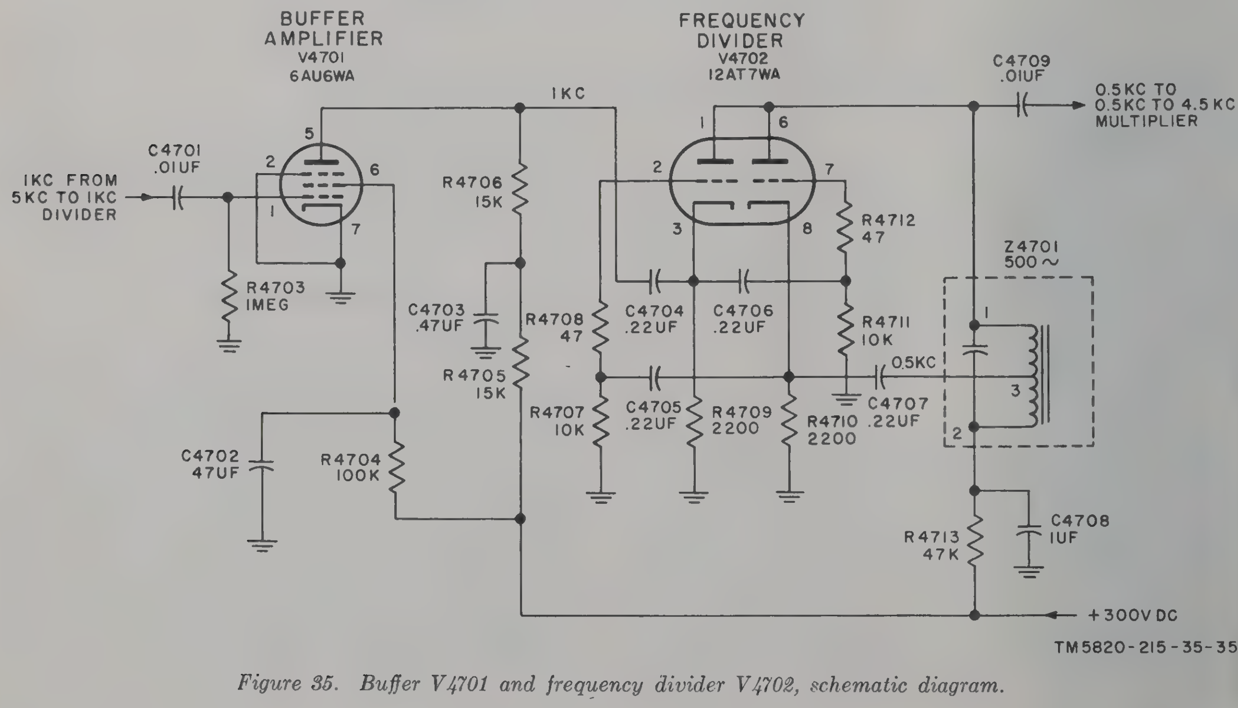


Figure 35. Buffer V4701 and frequency divider V4702, schematic diagram.

to the exciter-monitor. This frequency is also coupled through a rectifier diode to meter M701 (par. 46*l*). Resistor R4720 and capacitor C4713 decouple the plate circuit from the power supply.

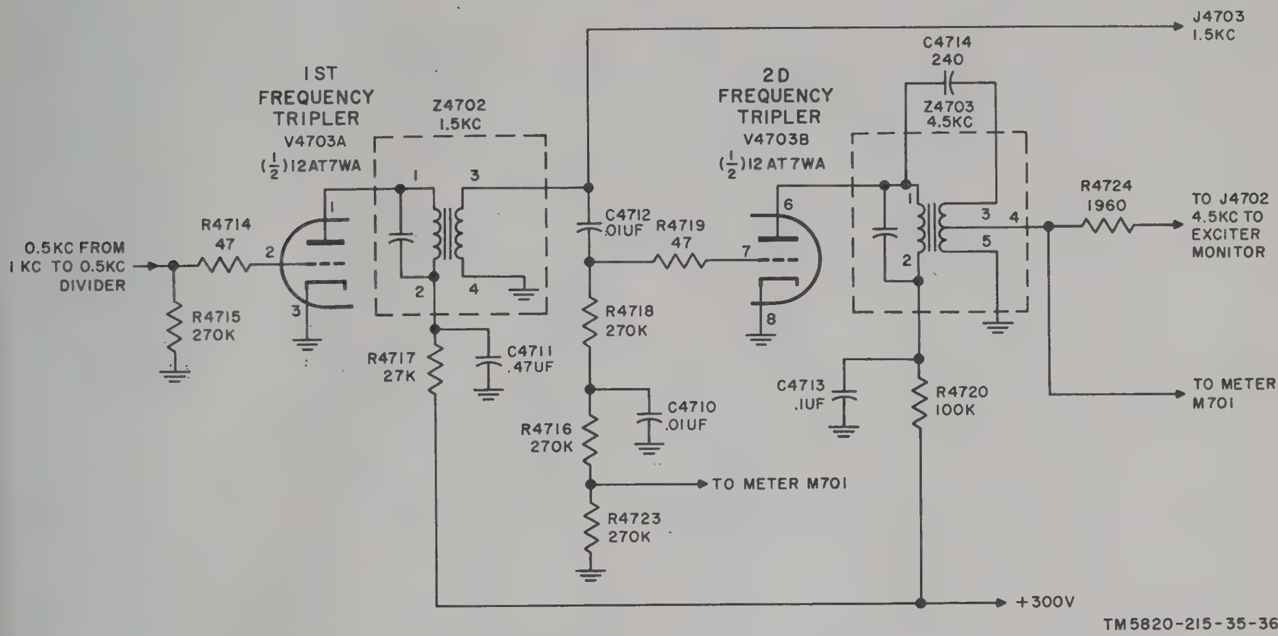


Figure 36. First and second frequency triplers, V4703A and V4703B, schematic diagram.

Section VI. METERING AND POWER INPUT CIRCUITS

46. Metering Circuits

(fig. 37)

The metering circuit, which includes M701 and switch S701, provides for front-panel measurement at any of 12 key points within the frequency standard compartment. All the useful frequencies that are generated within this compartment are brought out to switch S701. The front sections of S701A and S701B ground all input voltages except the one to be measured by meter M701. The circuits which are completed when METER switch S701 is placed in each position are described in *a* through *l* below.

a. OVEN-OSC. When switch S701 is placed in this position, crystal oscillator oven voltage is coupled from V607 (fig. 27) through C640 and applied across R646. Rectified current flows from cathode to anode of CR601, through R647, contacts 1 and 11 of S701A rear, and meter M701 to ground. Capacitor C641 filters the rectified output of CR601, and R647 limits the current flow through the meter.

b. 1 MC OSC. When S701 is in this position, rectified grid current from V604 flows through meter series limiting resistor R617, contacts 2 and 11 of S701A rear, and the meter. Capacitor C619 and resistor R616 filter this rectified current so that the meter indicates the level of the 1-mc oscillator oven-controlled signal.

c. 900 KC DIV. When switch S701 is in this position, rectified grid current from V901 is routed to the meter through contacts 3 and 11 of S701A rear. Resistors R901 and R911 are meter current limiting resistors, and C901 filters the rectified current.

d. 300 KV DIV. When switch S701 is in this position, rectified grid current from V902A is routed to the meter through contacts 4 and 11 of S701A rear. The minor components for this position perform functions similar to those described in *c* above.

e. 100 KC DIV. When switch S701 is in this position, rectified grid current from V902B is routed to the meter through contacts 5 and 11 of S701A rear. The minor components in this position perform functions similar to those described in *c* above.

f. 100 KC GEN. When switch S701 is placed in this position, the 100-kc signal from the plate circuit

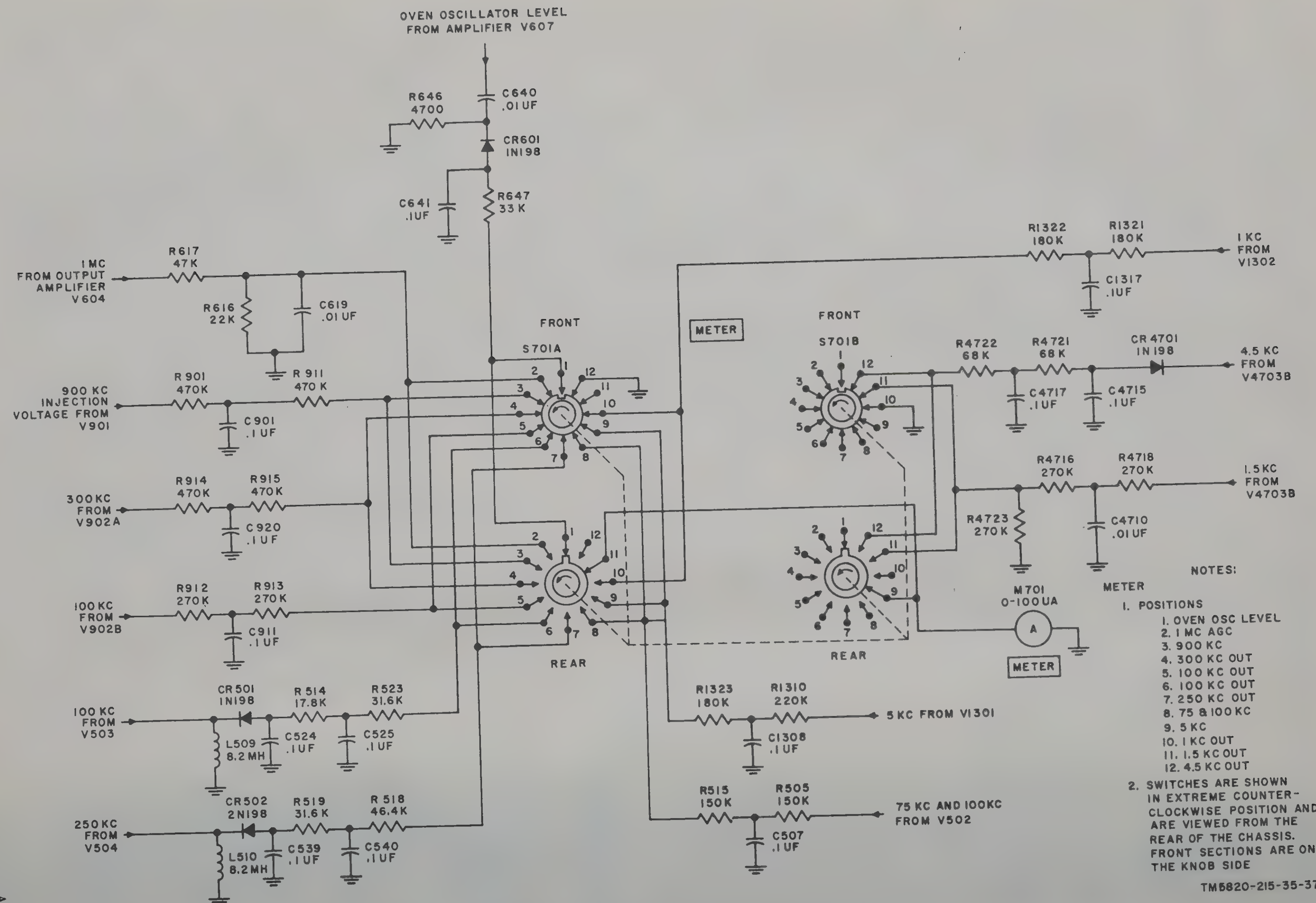


Figure 37. Metering circuit, schematic diagram.

of V503 (fig. 29) is applied across L509. This signal is rectified by CR501, filtered by C524, R514, and C525, and routed to the meter through R523 and contacts 6 and 11 of S701A rear.

g. 250 KC GEN. This circuit is similiar to the one used for the 100 KC GEN position (*f* above) except for reference symbols. Similarly located components in both positions perform identical functions. The rectified meter current is routed through contacts 7 and 11 of S701A rear.

h. 75/100 KC. When switch S701 is in this position, rectified grid current from V502 is routed through contacts 8 and 11 of S701A rear. Resistors R505 and R515 are meter current limiting resistors, and capacitor C507 filters the rectified current.

i. 5 KC DIV. When switch S701 is in this position, rectified grid current from V1301 is routed through contacts 9 and 11 of S701A rear. The minor components perform the same function as those described in *h* above.

j. 1 KC DIV. Contacts 10 and 11 of S701A rear complete the circuit for the rectified grid current from V1302. Resistors R1321 and R1322 are series limiting resistors for the meter, and C1317 filters the rectified current.

k. 1.5 KC GEN. Contacts 11 and 9 of S701B rear complete the circuit for the rectified grid current from the grid circuit of V4703B. Resistors R4716 and R4718 are series current limiting resistors, and R4723 is a meter shunt. Capacitor C4710 filters the ac component.

l. 4.5 KC GEN. When S701 is in this position, the 4.5-kc signal at the secondary tap of Z4703 (par. 45*b*) is rectified by CR4701. The rectified current is limited and filtered by C4715, R4721, C4717, and R4722. The rectified current is routed to the meter through contacts 9 and 12 of S701B rear.

47. Frequency Standard Compartment, Power Input and Filament Circuits

a. All the power connections to the frequency standard compartment are brought in through J701. The +150-volt and +300-volt dc lines are connected through terminals 4 and 5 of J701 and are distributed throughout the frequency standard compartment.

b. Filament power is applied through transformer T701 which steps down the applied 115-volt ac input to 12.6 volts ac. The secondary of T701 is center-tapped to provide 6.3 volts from each side to ground. Transformer T701 supplies filament power for all the tubes in this compartment. Capacitors C636, C637, C526, C527, C921, C922, C4718, and C4719 place the filament circuits at RF ground and prevent undesired coupling between stages through the filament string.

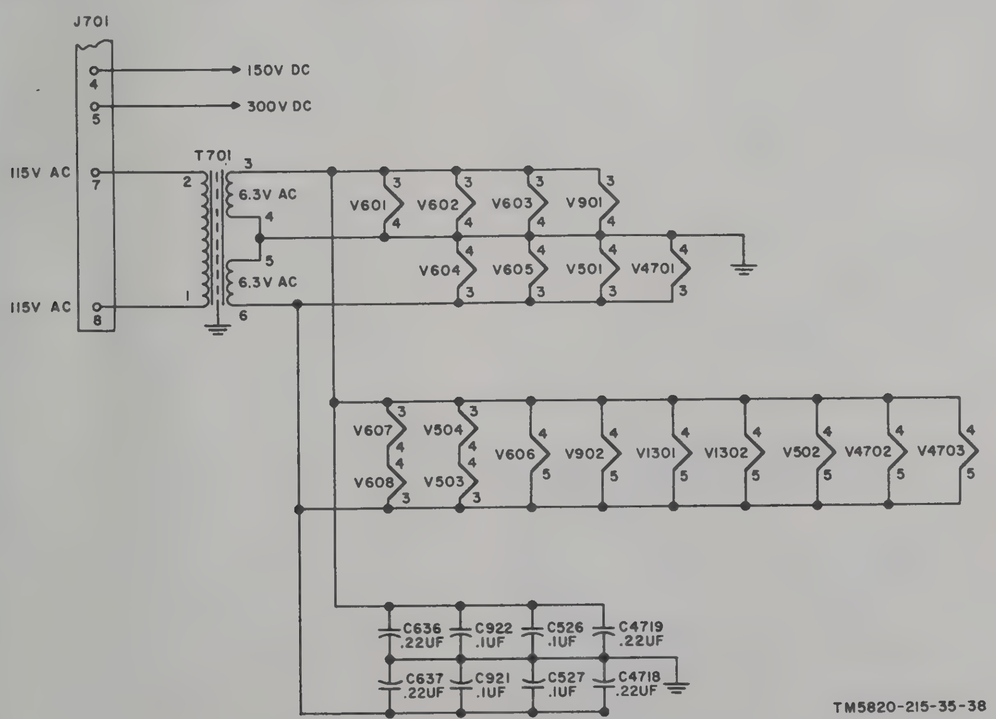


Figure 38. Power input and filament circuit.

CHAPTER 4

THEORY OF EXCITER-MONITOR

Section I. MIXER-AMPLIFIERS

48. General

The current coverage in this chapter supplements the block diagram coverage in paragraph 6 and figure 5. The mixer-amplifier section of the exciter-monitor chassis produces output frequencies, ranging from 1.7 mc to 32.3 mc, by mixing the 300-kc twin-sideband signal from the twin-sideband modulator with an appropriate frequency from the stabilized master oscillator (smo) section. For details on the mixing frequencies involved, refer to the mixer-amplifier frequency scheme chart shown in paragraph 6*a*(4).

49. Band 1 Mixer-Amplifier

(fig. 39)

The band 1 mixer-amplifier is used when the desired output frequency is in the 1.7- to 2.3-mc range. The band 1 mixer-amplifier section accepts the 300-kc tsb signal and mixes it with a signal from the smo RF chassis. In this band, the injection signal from the smo is always 300 kc higher than the desired output frequency. The output of the mixer is amplified by three RF amplifiers and applied to Radio Frequency Amplifier AM–1154A/G for transmission.

a. Band 1 Mixer V1801.

(1) The 300-kc tsb signal is coupled through C1801, developed across grid resistor R1801, and then coupled through parasitic oscillation suppressor R1817 to the control grid, pin 7, of dual triode V1801. The injection signal from the smo section is coupled through C1802, developed across grid resistor R1803, and then coupled through parasitic oscillation suppressor R1818 to the other control grid, pin 2, of V1801. Assume that an output frequency of 1,900 kc is desired. The 300-kc tsb signal mixes with an injection frequency of 2,200 kc to produce a difference frequency of 1,900 kc across plate-tuned circuit Z1801 consisting of C1803, C1804, C1805, C1843, and variable inductor L1801. Fixed inductor L1808 provides a dc path to the plate, pin 1, of V1801. Capacitor C1805 is a trimmer and L1801 is mechanically linked with the frequency control shafts so that the plate tuned circuit is always resonant to the desired output frequency.

(2) Resistor R1802 is the common cathode resistor that permits mixer operation of V1801. Plate decoupling is provided by R1804 and C1806. The output of plate-tuned circuit Z1801 is coupled through C1807 to the input of first band 1 amplifier V1802.

b. First Band 1 Amplifier V1802. The first band 1 amplifier amplifies the input signal and applies it to the second band 1 amplifier.

(1) The output of mixer V1801 is coupled through C1807 and applied across grid tank circuit Z1802 which consists of variable inductor L1802, trimmer C1808, C1809, and C1810. A portion of the voltage developed across the grid tank circuit appears across grid resistor R1805 and is applied to the control grid of V1802. Resistor R1819 and capacitor C1836 are a grid decoupling network that prevents the input signal from being coupled into the other circuits through the agc bus. The agc voltage is obtained from agc control tube V4502 (par. 21) which maintains the gain of V1802 at the correct level. The cathode is returned to ground through cathode resistor R1806, feedthrough capacitor C1839, ad contacts 6 and 8 of relay K4801. This relay automatically opens the cathode circuit (disabling the mixer-amplifier stages) while the smo is going through the tuning cycle.

(2) The output of V1802 is applied directly across plate tank circuit Z1803 consisting of C1814, trimmer C1815, and variable inductor L1803. The grid and plate circuits of this stage are tuned by L1802 and L1803, which are ganged to the main tuning controls.

(3) Capacitor C1811 is a cathode resistor bypass, R1807 is the screen grid voltage-dropping resistor, and C1812 is the screen grid bypass. Resistor R1808 and capacitor C1813 are a plate decoupling network. Test points TP1802, TP1810, TP1812, and TP1803 provide access for grid, cathode, and plate circuit measurements.

c. Second Band 1 Amplifier V1803.

(1) The signal voltage developed across Z1803 is coupled through C1816 and applied across tuned circuit Z1804 which consists of variable inductor L1804, trimmer C1817, C1818, C1819, and C1820. The control grid of V1803 is returned to ground through grid resistor R1809, grid decoupling resistor R1820, and gain frequency control R803. Gain frequency control R803 is connected between —105 volts and ground and is mechanically ganged with the FREQ-MC shaft. When the frequency of operation is changed, the bias on V1803 is automatically varied to compensate for changes in the gain of V1803 at different frequencies.

(2) Crystal diode CR1801 is connected between the agc bus and the control grid return of V1803. This arrangement permits the agc voltage to be applied to V1803 but prevents any negative voltage from R803 (when it exceeds the agc voltage) from being coupled to the grid of V1802.

(3) The output of V1803 is developed across Z1805 (consisting of variable inductor L1805, trimmer C1824, and C1823), and coupled through C1825 to the band 1 output amplifier. The second band 1 amplifier is permeability-tuned by L1804 and L1805, which are ganged to the frequency control shafts. Resistor R1820 and capacitor C1842 remove power supply ripples on the —105-volt line from the V1803 grid circuit. Resistor R1810 and capacitor C1821 provide cathode bias. The cathode is returned to ground through cathode disabling relay K4801 (*b*(1) above). Resistor R1811 is the screen grid voltage-dropping resistor, and C1822 is the screen grid bypass. Resistors R1812 and R1813 and capacitor C1838 are the plate decoupling network. Test points TP1804, TP1808, TP1813, and TP1805 permit access to the grid, cathode, and plate circuits for voltage or waveform measurements.

d. Band 1 Output Amplifier V1804.

(1) The output of V1803 is coupled through C1825 and applied across Z1806, which consists of variable inductor L1806, trimmer C1827, and C1828. The portion of the signal voltage that is developed in the plate circuit of V1804 is fed back through C1829 and applied across R1814 and C1826. This signal is 180° out of phase with the input signal and improves the overall linearity of the output stage.

(2) Cathode bias is supplied by R1815 and C1830. The cathode circuit is returned to ground through contacts 6 and 8 of cathode disabling relay K4801 (*b*(1) above). Inductor L1811 and capacitor C1831 decouple the screen grid from the +125-volt supply line. Resistor R1816 and C1835 are a plate decoupling network. The signal developed across the output tank circuit Z1807 (consisting of C1832, C1833, trimmer C1834, C1837, and variable inductor L1807) is a twin-sideband signal within the range of 1.7 to 2.3 mc.

(3) The stage is permeability-tuned by L1806 and L1807. A portion of the input signal to V1804 is link-coupled from L1806 and is available at TP1809. Test points TP1806, TP1814, and TP1807 provide access to the grid, cathode, and plate circuits for measurement purposes.

50. Band 2 Mixer-Amplifier

(fig. 40)

The band 2 mixer-amplifier section is used when the desired output frequency of the exciter-monitor is between 2.3 to 4.3 mc. Band 2 mixer V1901 accepts the 300-kc tsb signal and mixes it with a 2- to 4-mc signal from the smo RF chassis. The mixer output is tuned to the *sum* frequency of the two input frequencies, thereby providing an output of

2.3 to 4.3 mc. Except for minor differences in component values and the two circuits described in *a* and *b* below, this mixer-amplifier is identical with the band 1 mixer-amplifier described in paragraph 49.

a. The input circuit to mixer V1901 differs from the one used in V1801 (fig. 39). Series input resistor R1901 reduces the overall tsb signal input to this stage to compensate for the increased mixer gain at the frequencies involved. Resistor R1916 and capacitor C1901 provide the grid impedance across which the signal input is developed.

b. Resistor R1922, in the grid circuit of V1903, serves as part of a voltage divider with R1921 from the arm of R803 to ground. Since the voltage across R803 is applied to at least one stage each of in the five mixer-amplifier sections (bands 1 through 5), a different resistive network is used to compensate for gain differences at different frequency ranges.

51. Band 3 Mixer-Amplifier

(fig. 41)

The band 3 mixer-amplifier section consists of a mixer and two stages of RF amplification. When an output frequency within the range of 4.3 to 8.3 mc is required from the exciter-monitor compartment, both the band 1 (par. 49) and band 3 mixer-amplifier sections are used. The band 3 mixer accepts the 1.7- to 3.7-tsb output from the band 1 mixer-amplifier section and heterodynes this signal with an injection signal (6 to 12 mc) from the smo RF chassis to produce the desired output frequency. The output of mixer V2001 is amplified by band 3 amplifiers V2002 and V2003 and is available at J2002 for application to Radio Frequency Amplifier AM–1154A/G.

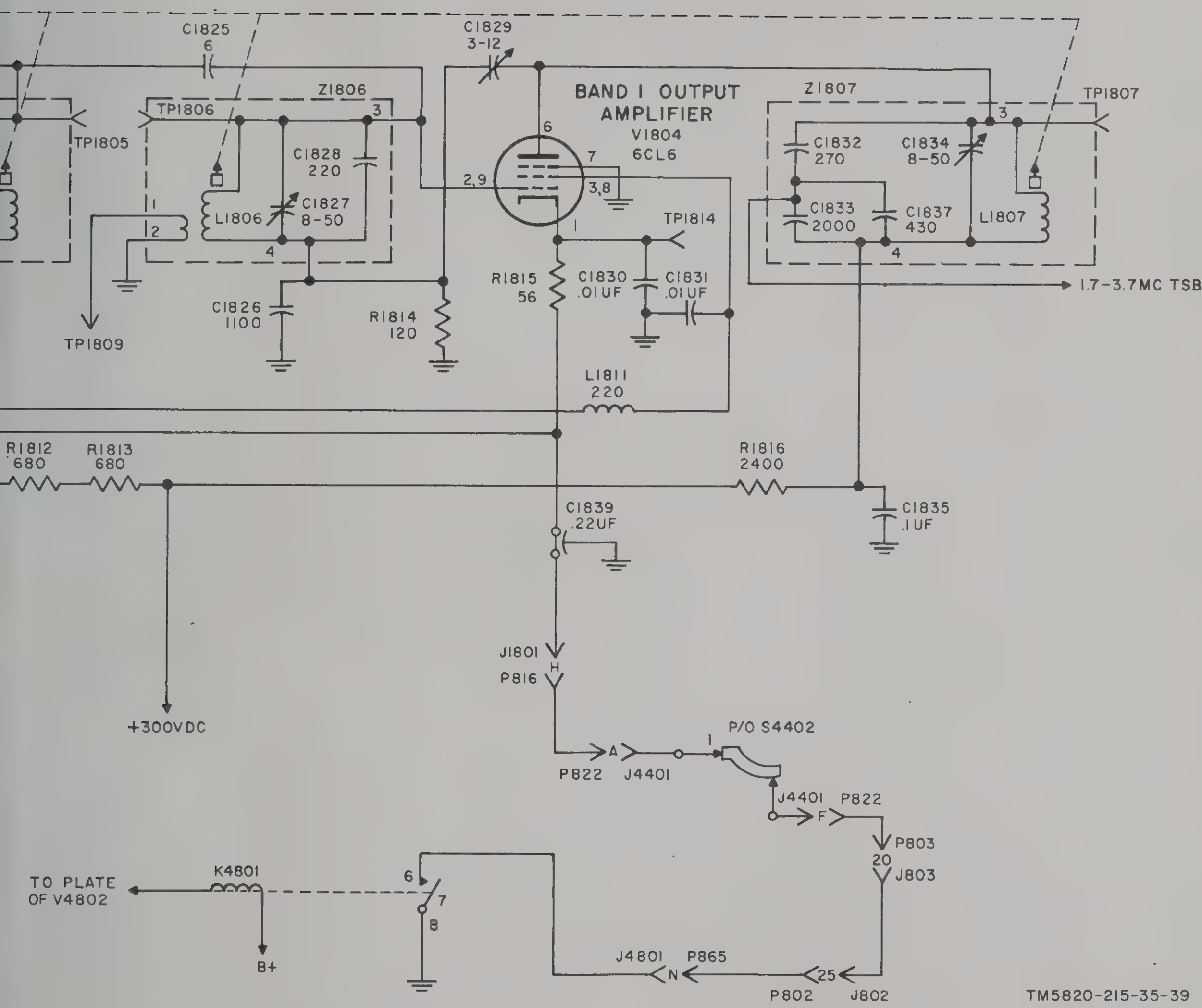
a. Band 3 Mixer V2001.

(1) A frequency within the range of 1.7 to 3.7 mc (containing tsb or single-sideband (ssb) modulation) is applied from the band 1 mixer-amplifier section (par. 49), developed across R2001, and coupled to mixer V2001 through parasitic oscillation suppressor R2013. Resistor R2001 serves as the grid impedance and also matches the grid input circuit to the cable that connects the input of mixer V2001 to the band 1 mixer-amplifier output stage. An injection signal from the smo RF chassis is applied through C2002 to the other grid (pin 2) of the dual triode. This injection signal is the third harmonic (6 to 12 mc) of the smo oscillator (basic frequency 2 to 4 mc) and it tracks the tsb input signal to produce the desired output frequency across plate load Z2001, which is tuned to the difference frequency of the two inputs to V2001. Refer to paragraph 6*a*(4), the mixer-amplifier frequency scheme chart, for an analysis of the frequencies used to produce the desired outputs from the exciter-monitor compartment.

(2) The output of mixer V2001 is applied across Z2001, which consists of variable inductor L2001, C2003, C2004, and trimmer C2005. The stage is permeability-tuned by a slug within L2001 which is ganged to the FREQ-MC and FREQ-KC controls. Resistor R2003 is the grid resistor for the pin 2 control grid, and R2014 is a parasitic oscillation suppressor. Plate decoupling is performed by R2004 and C2010; L2006 provides a dc path to the plate, pin 1, of V2001. The output of the mixer is coupled through C2009 to band 3 amplifier V2002. Test point TP2001 provides access for plate circuit measurements.

b. Band 3 Amplifier V2002. This stage amplifies the 4.3- to 8.3-mc twin-sideband signal and applies it to the band 3 output stage.

(1) The 4.3- to 8.3-mc tsb input signal from mixer V2001 is developed across Z2002 (consisting of variable inductor L2002, trimmer C2006, C2007, and C2008). A portion of the coupled signal appears across grid resistor R2005 and is applied directly to the control grid of V2002. Resistor R2016 and capacitor C2027 decouple the grid preventing undesired interaction through the agc network. The grid is returned to ground through gain-frequency control R803 which is ganged with the FREQ-MC shaft. This arrangement varies the bias on V2002 to compensate for gain variations at this tube for different frequency settings of the FREQ-MC shaft. Resistors R2015 and R2016 compose a voltage divider in parallel with the lower portion of R803. This resistive network reduces the gain-frequency bias voltage



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2.3 to 4.3 mc. Except for minor differences in component values and the two circuits described in *a* and *b* below, this mixer-amplifier is identical with the band 1 mixer-amplifier described in paragraph 49.

a. The input circuit to mixer V1901 differs from the one used in V1801 (fig. 39). Series input resistor R1901 reduces the overall tsb signal input to this stage to compensate for the increased mixer gain at the frequencies involved. Resistor R1916 and capacitor C1901 provide the grid impedance across which the signal input is developed.

b. Resistor R1922, in the grid circuit of V1903, serves as part of a voltage divider with R1921 from the arm of R803 to ground. Since the voltage across R803 is applied to at least one stage each of in the five mixer-amplifier sections (bands 1 through 5), a different resistive network is used to compensate for gain differences at different frequency ranges.

51. Band 3 Mixer-Amplifier
(fig. 41)

The band 3 mixer-amplifier section consists of a mixer and two stages of RF amplification. When an output frequency within the range of 4.3 to 8.3 mc is required from the exciter-monitor compartment, both the band 1 (par. 49) and band 3 mixer-amplifier sections are used. The band 3 mixer accepts the 1.7- to 3.7-tsb output from the band 1 mixer-amplifier section and heterodynes this signal with an injection signal (6 to 12 mc) from the smo RF chassis to produce the desired output frequency. The output of mixer V2001 is amplified by band 3 amplifiers V2002 and V2003 and is available at J2002 for application to Radio Frequency Amplifier AM–1154A/G.

a. Band 3 Mixer V2001.

(1) A frequency within the range of 1.7 to 3.7 mc (containing tsb or single-sideband (ssb) modulation) is applied from the band 1 mixer-amplifier section (par. 49), developed across R2001, and coupled to mixer V2001 through parasitic oscillation suppressor R2013. Resistor R2001 serves as the grid impedance and also matches the grid input circuit to the cable that connects the input of mixer V2001 to the band 1 mixer-amplifier output stage. An injection signal from the smo RF chassis is applied through C2002 to the other grid (pin 2) of the dual triode. This injection signal is the third harmonic (6 to 12 mc) of the smo oscillator (basic frequency 2 to 4 mc) and it tracks the tsb input signal to produce the desired output frequency across plate load Z2001, which is tuned to the difference frequency of the two inputs to V2001. Refer to paragraph 6*a*(4), the mixer-amplifier frequency scheme chart, for an analysis of the frequencies used to produce the desired outputs from the exciter-monitor compartment.

(2) The output of mixer V2001 is applied across Z2001, which consists of variable inductor L2001, C2003, C2004, and trimmer C2005. The stage is permeability-tuned by a slug within L2001 which is ganged to the FREQ-MC and FREQ-KC controls. Resistor R2003 is the grid resistor for the pin 2 control grid, and R2014 is a parasitic oscillation suppressor. Plate decoupling is performed by R2004 and C2010; L2006 provides a dc path to the plate, pin 1, of V2001. The output of the mixer is coupled through C2009 to band 3 amplifier V2002. Test point TP2001 provides access for plate circuit measurements.

b. Band 3 Amplifier V2002. This stage amplifies the 4.3- to 8.3-mc twin-sideband signal and applies it to the band 3 output stage.

(1) The 4.3- to 8.3-mc tsb input signal from mixer V2001 is developed across Z2002 (consisting of variable inductor L2002, trimmer C2006, C2007, and C2008). A portion of the coupled signal appears across grid resistor R2005 and is applied directly to the control grid of V2002. Resistor R2016 and capacitor C2027 decouple the grid preventing undesired interaction through the agc network. The grid is returned to ground through gain-frequency control R803 which is ganged with the FREQ-MC shaft. This arrangement varies the bias on V2002 to compensate for gain variations at this tube for different frequency settings of the FREQ-MC shaft. Resistors R2015 and R2016 compose a voltage divider in parallel with the lower portion of R803. This resistive network reduces the gain-frequency bias voltag

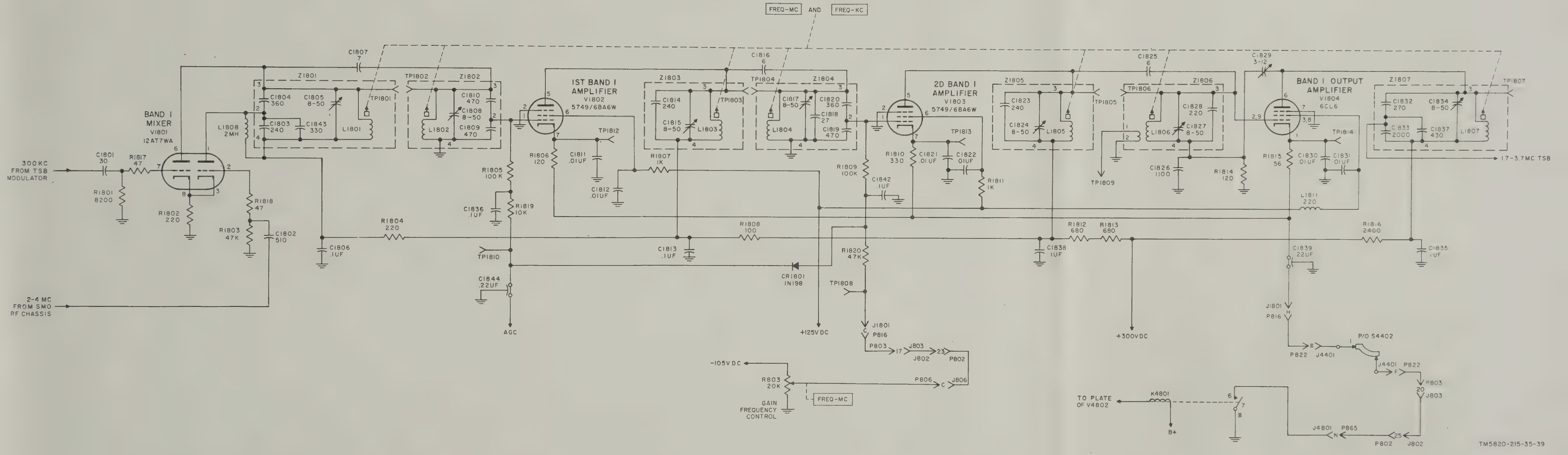
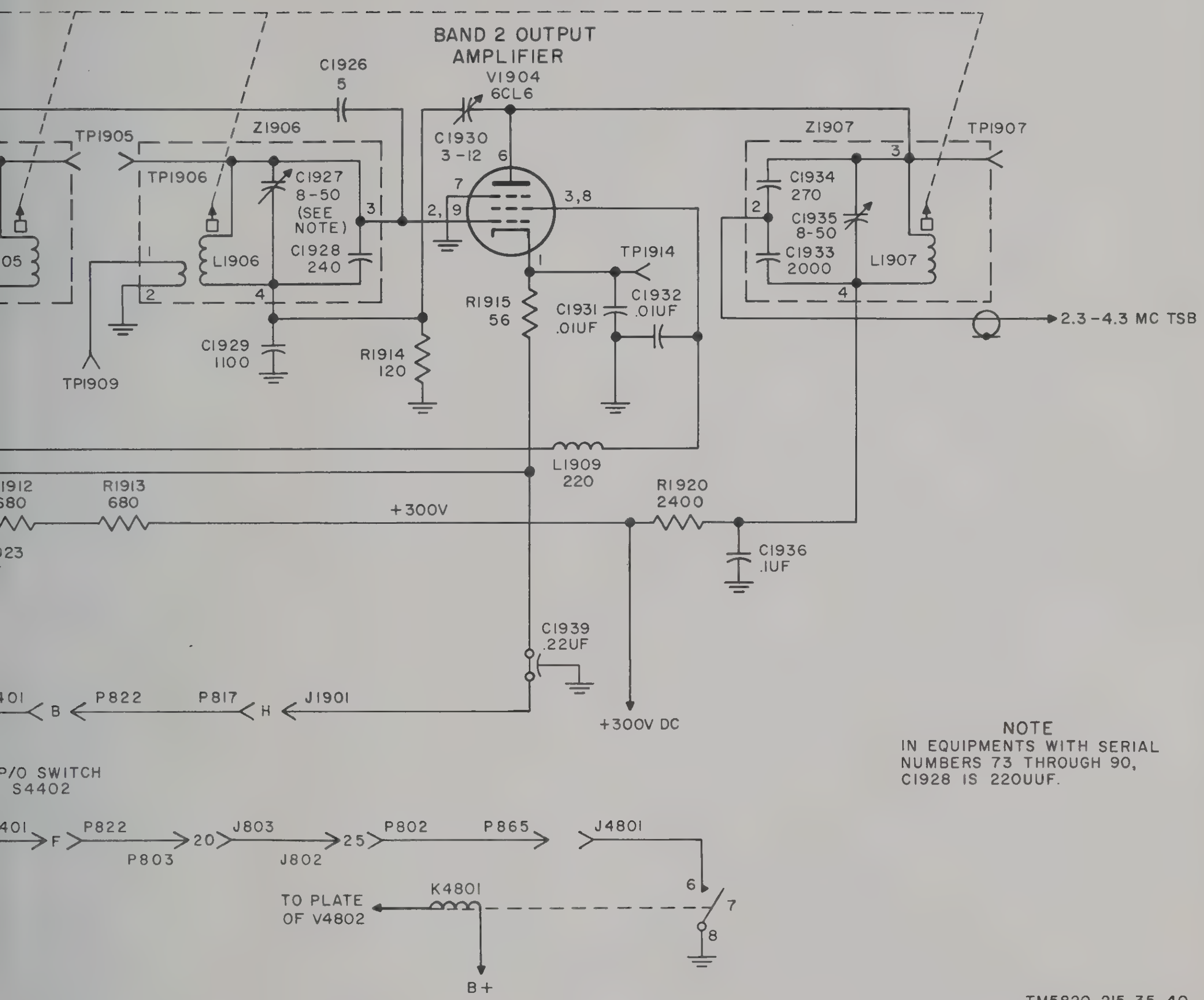


Figure 39. Band 1 mixer-amplifier, schematic diagram.



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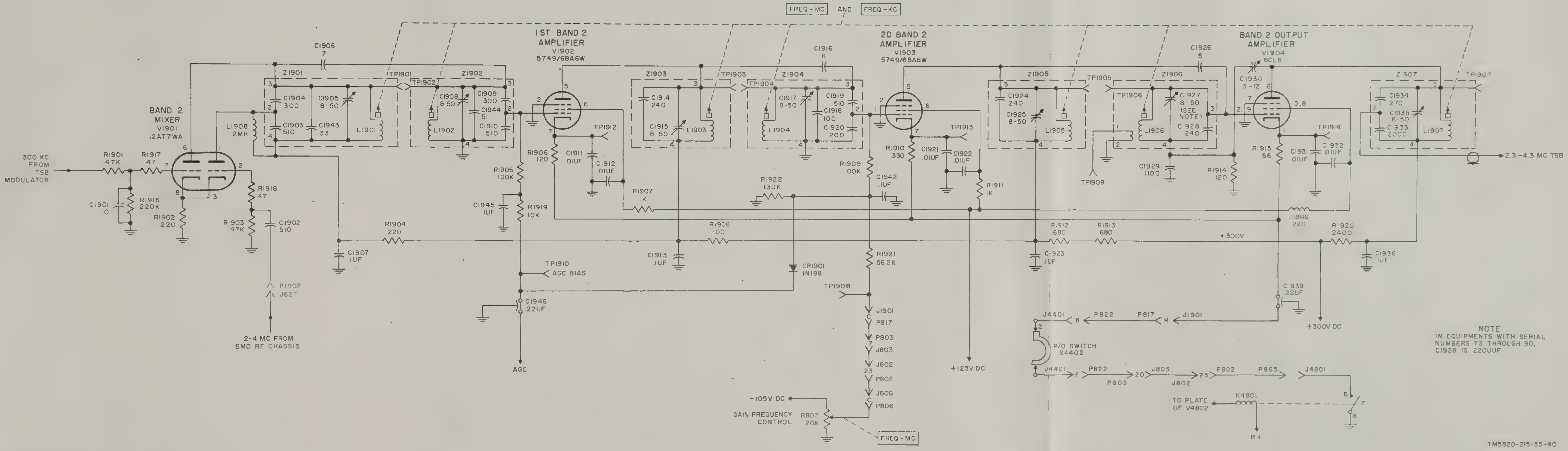
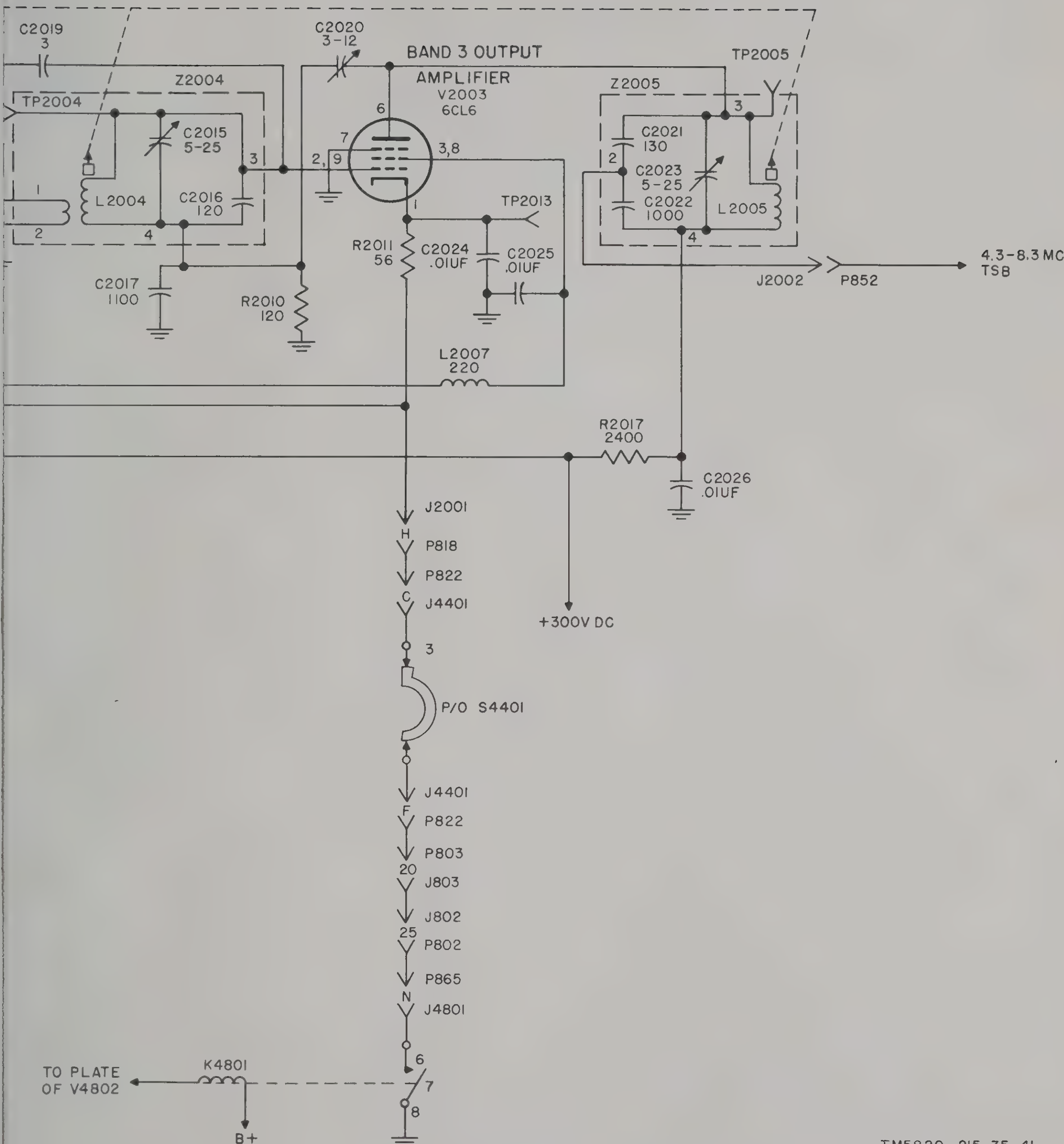


Figure 40. Band 2 mixer-amplifier, schematic diagram.



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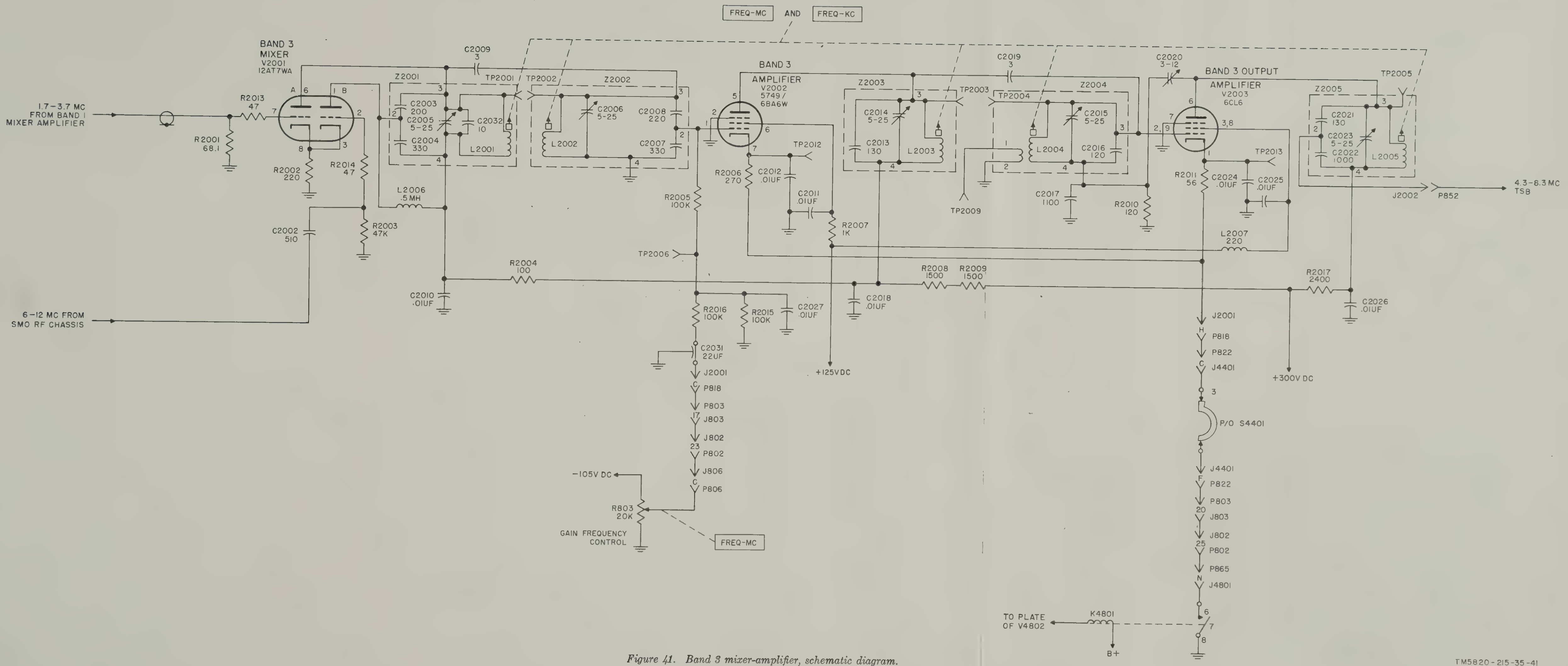

Figure 41. Band 3 mixer-amplifier, schematic diagram.

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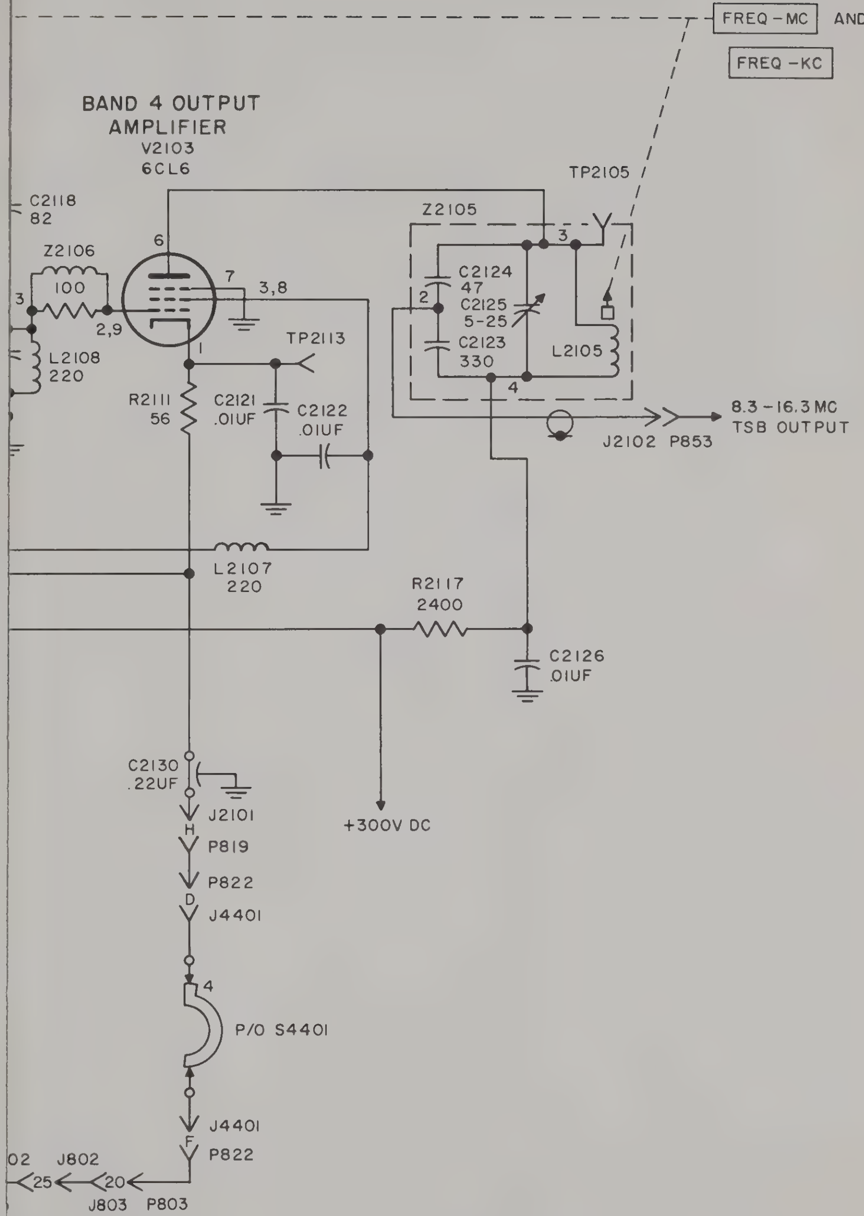

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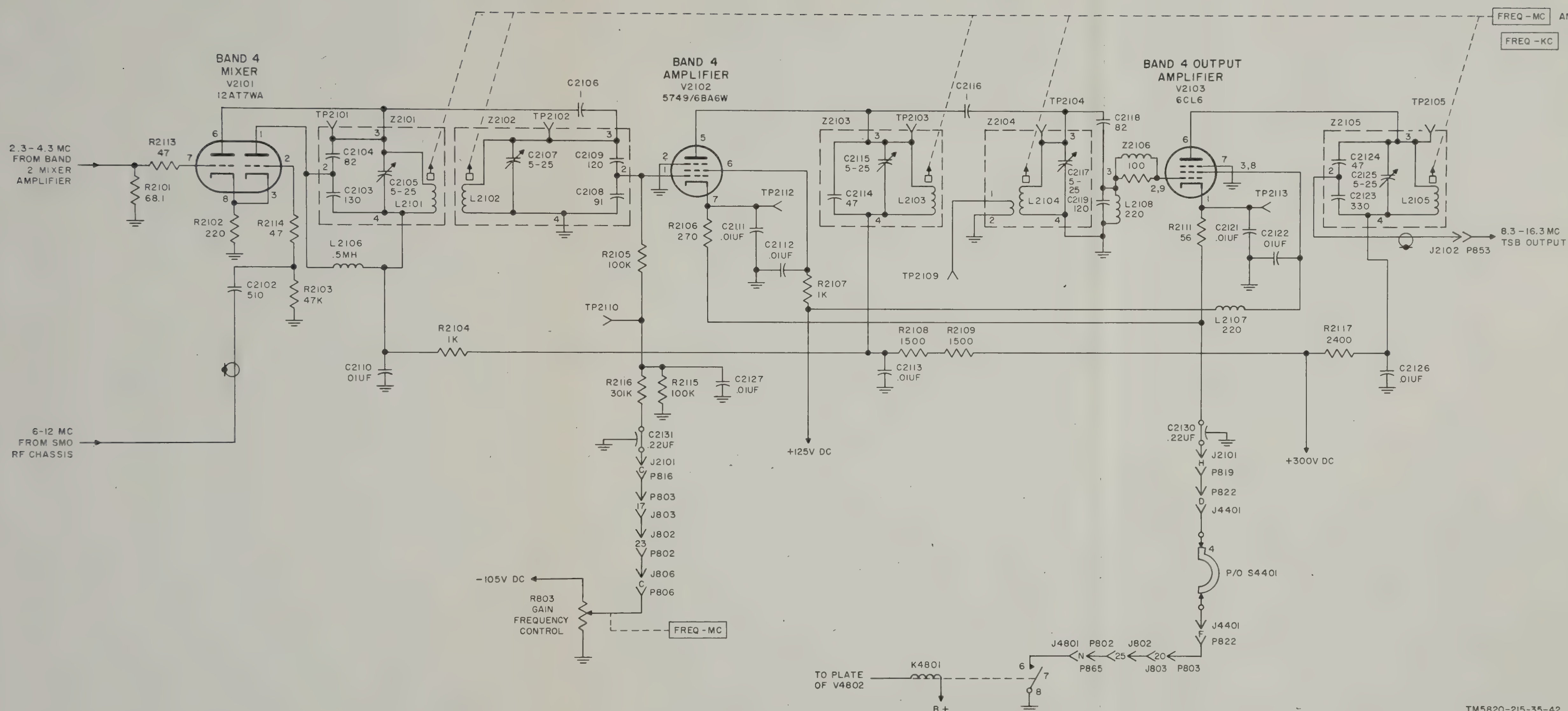
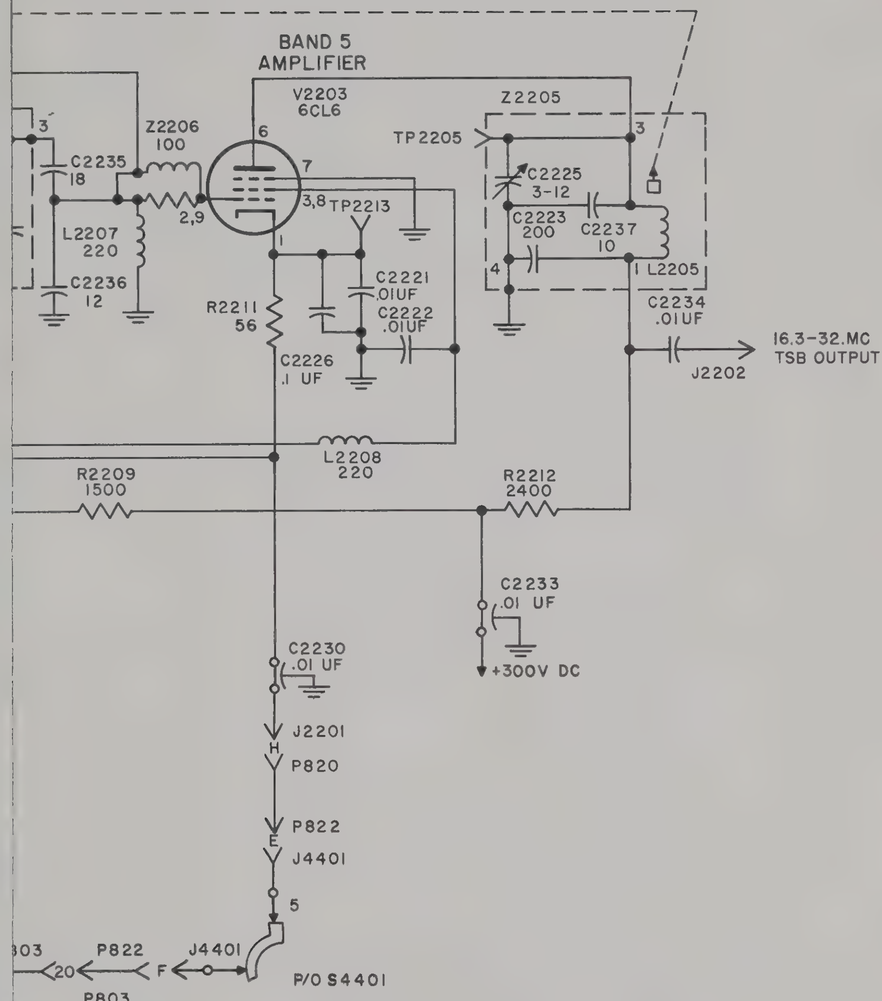


Figure 42. Band 4 mixer-amplifier, schematic diagram.



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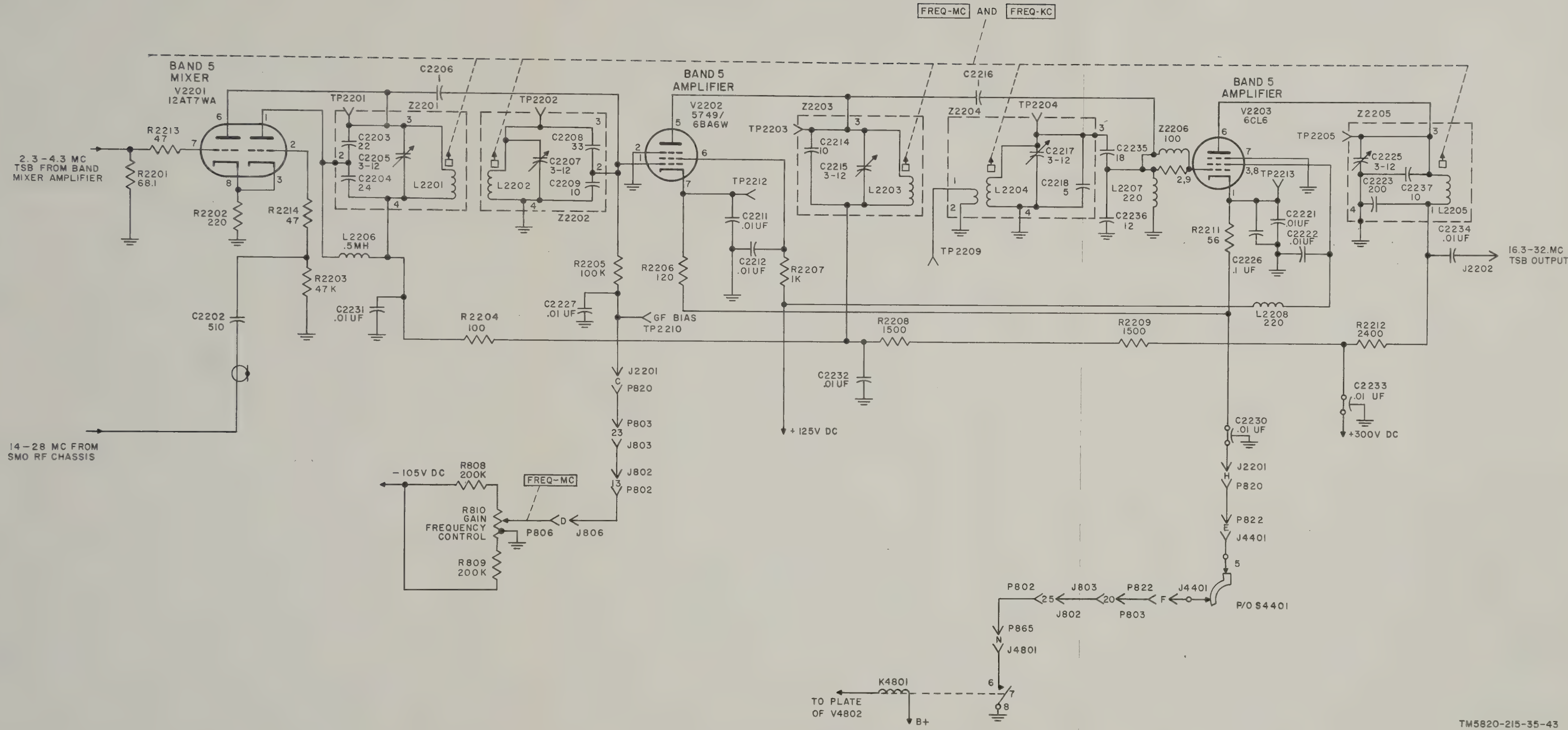


Figure 43. Band 5 mixer-amplifier, schematic diagram.

(from R803) that is applied to the grid of V2002.

(2) The cathode of this stage is returned to ground through cathode resistor R2006, switch S4401, and contacts 6 and 8 of relay K4801. The relay opens contacts 6 and 8, disabling the stage, during the smo tuning cycle. Capaictor C2012 is the cathode bypass. The output of this stage is developed across Z2003 (consisting of C2013, trimmer C2014, and variable inductor L2003) and coupled to the output amplifier through C2019. The stage is permeability-tuned by L2002 and L2003 which are ganged to the FREQ-MC and FREQ-KC shafts. Resistor R2007 is the screen grid voltage-dropping resistor and C2011 is the screen grid bypass. Resistors R2008, R2009, and capacitor C2018 are the plate decoupling network. Test points TP2002, TP2006, TP2012, and TP2003 provide access to the grid, cathode, and plate circuit for measurements.

c. *Band 3 Output Amplifier V2003.* This stage amplifies the 4.3- to 8.3-mc twin-sideband signal from band 3 amplifier V2002 and applies it to Radio Frequency Amplifier AM–1154A/G.

(1) The input signal is developed across Z2004 (consisting of variable inductor L2004, trimmer C2015, and C2016) and applied directly to the control grid. The loop winding (1 and 2 of Z2004) supplies a signal for test purposes to TP2009. A feedback voltage from the plate circuit is coupled through C2020 and developed across R2010 and C2017. This voltage is 180° out of phase with the input signal and improves the overall linearity of the output stage. The cathode of this stage is returned to ground through cathode resistor R2011, S4401, and contacts 6 and 8 of relay K4801. This relay opens the cathode circuit during the smo tuning cycle. Capacitor C2024 is a cathode bypass.

(2) The output of the stage is developed across Z2005 (consisting of C2021, C2022, trimmer C2023, and variable inductor L2005) and applied to Radio Frequency Amplifier AM–1154A/G. Inductor L2007 and capacitor C2025 are the screen grid decoupling network. The stage is tuned by L2004 and L2005, which are ganged to the FREQ-MC and FREQ-KC controls. Resistor R2017 and capacitor C2026 are the plate decoupling network for the output stage. Test points TP2004, TP2013, and TP2005 provide access to the grid, cathode, and plate circuits for measurements.

52. Band 4 Mixer-Amplifier
(fig. 42)

a. The band 4 mixer-amplifier section is used when the desired output frequency of the exciter-monitor compartment is between 8.3 and 16.3 mc. The band 4 mixer, V2101, accepts the 2.3- to 4.3-mc twin-sideband signal from the output of the band 2 mixer-amplifier section and mixes it with a 6- to 12-mc signal from the smo RF chassis. The plate load of the mixer stage, Z2101, is tuned to the *sum* of these two frequencies, therebey producing a frequency within the range of 8.3 to 16.3 mc. Two stages of amplification follow the mixer. The output of this section is applied to Radio Frequency Amplifier AM–1154A/G. Except for one minor circuit difference (*b* below), this circuit is identical with the band 3 mixer-amplifier covered in paragraph 51. Refer to that paragraph for detailed coverage of circuit components.

b. The only circuit difference between the band 3 and band 4 mixer-amplifiers (besides the values of tank circuit components to provide different frequencies of operation) is in the input circuit of band 4 output amplifier V2103. This stage uses impedance network Z2106 in the grid circuit to reduce the effects of parasitic oscillation at these frequencies.

53. Band 5 Mixer-Amplifier
(fig. 43)

a. The band 5 mixer-amplifier section is used when the desired output frequency of the exciter-monitor compartment is between 16.3 to 32.3 mc. The band 5 mixer, V2201, accepts the 2.3- to 4.3-mc twin-sideband signal from the output of the band 2 mixer-amplifier section and mixes it with a 14- to 28-mc signal (7th harmonic of the basic 2- to 4-mc signal of the stablized master oscillator) from the smo RF chassis. The plate load of mixer Z2201 is tuned to the sum of the two input frequencies, thereby producing a band of frequencies within the range of 16.3 to 32.3 mc.

b. Two stages of amplification follow the mixer stage. The output of this section is applied to Radio

Frequency Amplifier AM–1154A/G for transmission. The only difference between the band 5 mixer-amplifier and the band 3 (par. 51) and band 4 mixer-amplifier (par. 52) is that the grid circuit of band 5 amplifier V2202 is returned to gain-frequency control R810 instead of R803. This arrangement provides a lower value of bias for this stage to compensate for the reduced gain of this tube at this higher band of frequencies. Refer to paragraphs 51 and 52 for detailed operation of the components.

Section II. STABILIZED MASTER OSCILLATOR SUBCHASSIS

54. Stabilized Master Oscillator
(fig. 44)

a. The stabilized master oscillator (smo) V1101 is connected as a series-fed Hartley oscillator with the screen grid serving as the plate of the oscillator circuit. Feedback current in the circuit loop that contains C1106 and the lower half of L1101 produces oscillatory energy in the tank circuit.

b. The tuned circuit of the smo operates within the frequency range of 2 to 4 mc. The tuned circuit consists of L1101, winding 2–3 of Z1101, and C1101. The auxiliary winding, 4–5 of Z1101, is a saturable reactor that is wound on a core material having a magnetic permeability which is a function of the magnetizing force. The inductance of this winding (and also the secondary) is changed by a control current from smo control amplifier V1706 (par. 79) that corrects for any frequency error that may be introduced by the smo circuit. Inductor L1101 is ganged with the FREQ-KC shaft and changes the frequency of the oscillator when the frequency of operation is varied. Capacitors C1102, C1103, and C1104 provide the desired capacitance for the tuned circuit. Inductor L1102 is a trimmer adjustment and capacitor C1105 couples the smo-tuned circuit to the grid of V1101. The oscillator output is electron-coupled to the plate of V1101 and developed across plate load resistor R1103.

c. Grid leak bias for the smo is furnished by R1101 and C1105. Resistor R1107 and capacitor C1108 provide plate decoupling; resistor R1102 is the screen grid voltage-dropping resistor. All the components within the grid and cathode circuits of the smo are enclosed in a compartment whose temperature is controlled by heater HR1101. Thermostatic switch S1101 is normally closed during operation and opens when the compartment temperature is in excess of a predertemined value. Capacitor C1111 limits the arc across S1101 during switch opening or closing. The 2- to 4-mc output of the smo is coupled through C1107 to the control grid of V1102.

55. Smo Amplifier V1102
(fig. 44)

Smo amplifier V1102 amplifies the output of the smo and applies it to buffer amplifier V1503 (fig. 45). The smo output frequency is developed across R1104 and applied directly to the grid of V1102. The output of this stage is developed across plate load resistor R1106 and coupled through C1110 to buffer amplifier V1503. Resistor R1105 is a screen grid voltage-dropping resistor and C1109 is the screen grid bypass. Bias for this stage is provided by grid current through R1104.

56. Buffer Amplifier V1503
(fig. 45)

a. Buffer amplifier V1503 amplifies the smo output signal and isolates the smo from the loading effects of the mixer-amplifier and frequency multiplier stages. A plate-to-grid feedback loop monitors the amplitude of the buffer amplifier output and applies a negative dc voltage to the grid circuit. If the oscillator amplitude level increases, the grid of V1503 is biased more negatively and the gain of V1503 is reduced to compensate for the increased input. This arrangement maintains the buffer output amplitude at a relatively constant level.

b. The oscillator signal is applied across grid input network L1520 and R1512 paralleled by C1550, R1513, and C1551. An amplified version of this signal is developed across plate load Z1509. The RF voltage developed across plate load Z1509 is coupled back through C1552, rectified by CR1504, and appears as a negative voltage at the grid of V1503. To provide the correct bias for V1503, voltage divider CR1504, R1515, and R1514 supplies a positive voltage in series with the grid of V1503. The two voltages (negative rectified feedback voltage and the positive voltage developed across R1515 by the voltage divider action) add to provide approximately —4 volts on the grid of V1503. When the input voltage increases in amplitude, the feedback voltage also increases, thereby raising the negative

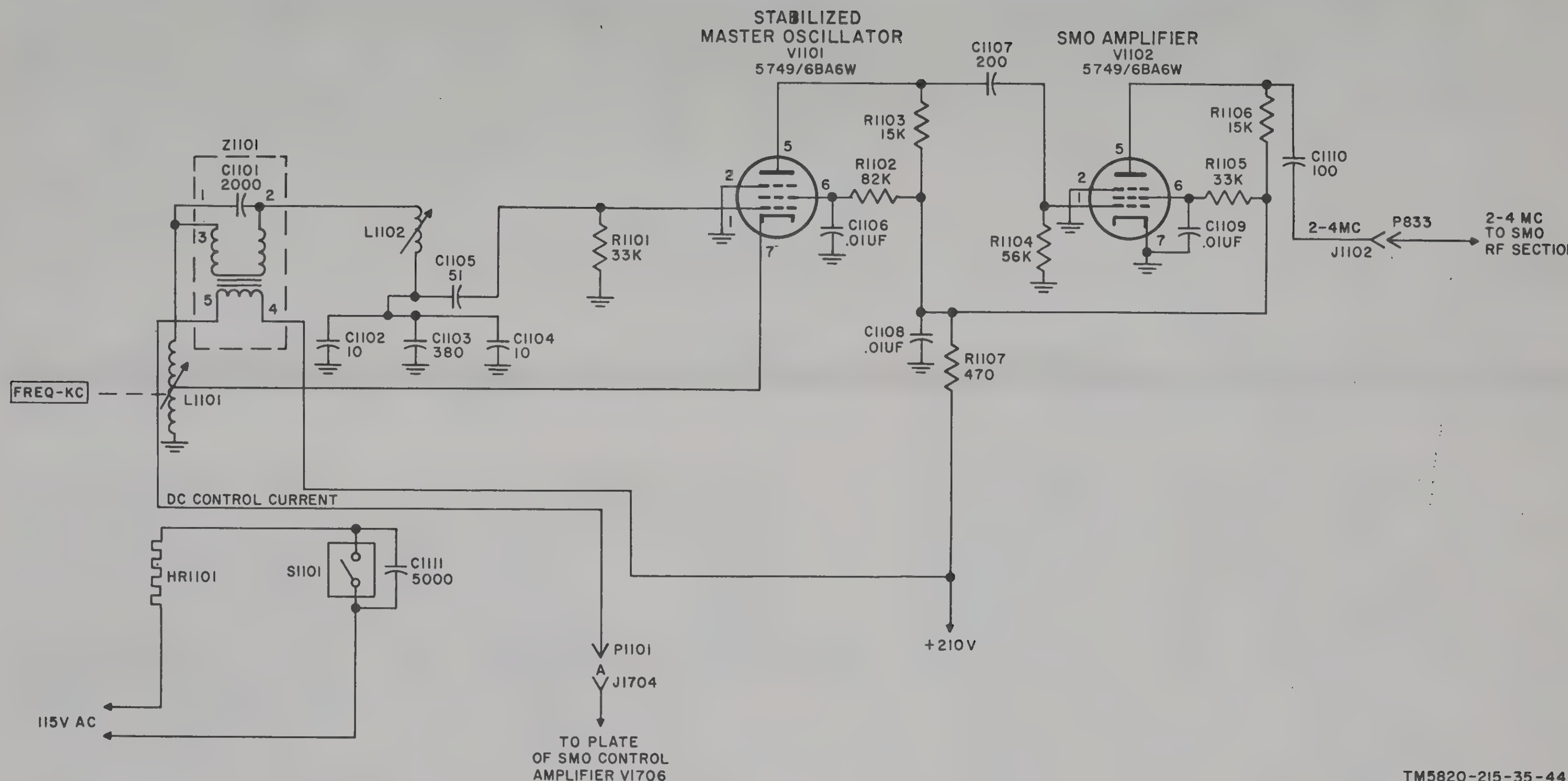


Figure 44. Stabilized master oscillator V1101, and smo amplifier V1102, schematic diagram.

bias voltage on V1503. The opposite is true when the input signal decreases in amplitude.

c. Resistors R1516 and R1517 are a voltage divider network that sets the screen grid voltage. Capacitor C1553 is the screen grid bypass. Plate decoupling is provided by R1518 and C1557. A portion of the voltage developed across Z1509 (consisting of variable inductor L1509, trimmer C1509, C1614, C1554, C1555, and C1556) is coupled to the monitor section (par. 86). The 2- to 4-mc voltage across the entire tuned circuit Z1509 is applied to frequency multiplier V1506 (par. 57). Capacitor C1558 couples Z1509 to Z1510. Impedance Z1510, consisting of variable inductor L1510, trimmer C1510, C1559, C1560, and C1561, provides the 2- to 4-mc signals to the band 1 and 2 mixer-amplifier circuits and to meter M701 through switch S804. Crystal CR1505 rectifies the voltage applied to the meter, and C1562, C1563, R1519, and R1540 are the filter current limiting network for the meter circuit. Test points TP1522, TP1533, TP1509, and TP1510 provide access to the grid, cathode, and plate circuits for measurements.

57. Frequency Multiplier V1506

(fig. 46)

a. The frequency multiplier stage generates the injection frequencies for the mixer stages within the bands 3 through 5 mixer-amplifiers. Frequency multiplier V1506 is inoperative when the exciter-monitor compartment is set to the band 1 or band 2 frequencies. When an output frequency of 4.3 to 8.3 mc (band 3) or 8.3 to 16.3 mc (band 4) is required, V1506 functions as a tripler, multiplying the 2- to 4-mc output of the smo to a frequency range of 6 to 12 mc. When the exciter-monitor is set to band 5 (16.3 to 32.3 mc), V1506 multiplies the input frequency by a factor of 7, thereby producing an injection frequency within the 14- to 28-mc range.

b. The 2- to 4-mc input signal is coupled through C1575 and developed across R1533. When the band switch is set to position 1 or 2, switch S1505 opens the path to the +300-volt supply, and V1506 is inoperative. When the 3 or 4 position of S1505 is used, the plate of V1506 is returned to the +300-volt supply through tuned plate load Z1513 (consisting of variable inductor L1513, trimmer C1513, C1579, and C1580). Inductor L1513 is ganged to the FREQ-MC and FREQ-KC shafts and resonates Z1513 to any frequency within the 6- to 12-mc range. The output of Z1513 is coupled through positions 3 and 4 of S1506 (on positions 1 and 2, the control grid of V1507 is grounded) to the control grid of buffer amplifier V1507. Resistor R1534 is the screen grid voltage-dropping resistor, and C1576 is the screen grid bypass for V1506. Plate and screen supply decoupling is provided by R1535, C1577, and C1578.

c. When the band switch is set to position 5, the plate of V1506 is returned to the +300-volt supply through the wiper and contact 5 of S1505 and Z1514 (consisting of variable inductor L1514, C1581, and trimmer C1514). Inductor L1514 is ganged to the FREQ-MC and FREQ-KC controls and resonates Z1514 to any frequency between 14 to 28 mc. The 14- to 28-mc output of Z1514 is coupled through C1582 and C1584 to Z1515 in the grid circuit of V1507. Capacitors C1583 and C1582 function as an ac voltage divider and reduce the amplitude of the band 5 frequencies applied to Z1515 and V1507. Test points TP1513, TP1514, and TP1515 provide access to Z1513, Z1514, and Z1515 for measurements.

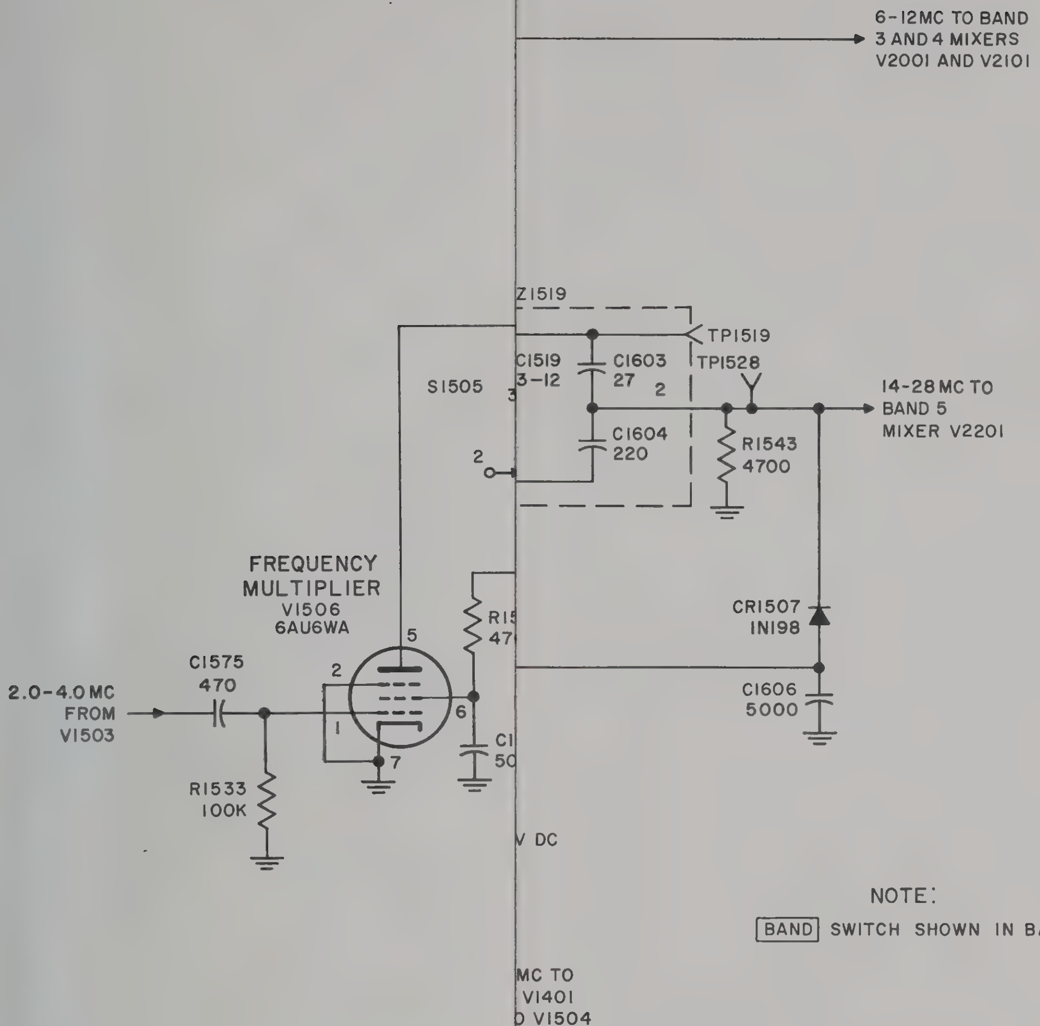
58. Buffer Amplifier V1507

(fig. 46)

a. Buffer amplifier V1507 isolates the frequency multiplier (par. 57) from loading effects of the mixers within the mixer-amplifier stages, and provides the required amplification to the 6- to 12-mc, and 14- to 28-mc frequencies.

b. When the band switch is placed in position 1 or 2, switch S1506 grounds the control grid of V1507. The plate circuit of V1507 is also disabled in positions 1 and 2, because switch S1507 removes the +300-volt supply from the plate. When the BAND switch is placed in position 3 or 4, switch S1506 couples the output of Z1513 to the grid of V1507. The Z1513 output is applied across the V1507 input network consisting of R1536, R1537, and C1587. A portion of the negative voltage that results from grid current flow is made available to test point TP1537 at the junction of R1536 and R1537. Tube V1507 amplifies the 6- to 12-mc signal and applies it to tuned plate circuit Z1516 (consisting of variable inductor L1516, trimmer C1516, C1590, C1591, and C1592) through switch S1507.

c. A portion of the 6- to 12-mc voltage at the junction of C1590 and C1591 is developed across R1540 and applied to mixer V1401 (par. 85) and to mixer V1504 (par. 61). The 6- to 12-mc output of Z1516 is coupled to another tuned circuit, Z1517 (consisting of variable inductor L1517, C1517,



NOTE:
BAND SWITCH SHOWN IN BAND I POSITION.

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bias voltage on V1503. The opposite is true when the input signal decreases in amplitude.

c. Resistors R1516 and R1517 are a voltage divider network that sets the screen grid voltage. Capacitor C1553 is the screen grid bypass. Plate decoupling is provided by R1518 and C1557. A portion of the voltage developed across Z1509 (consisting of variable inductor L1509, trimmer C1509, C1614, C1554, C1555, and C1556) is coupled to the monitor section (par. 86). The 2- to 4-mc voltage across the entire tuned circuit Z1509 is applied to frequency multiplier V1506 (par. 57). Capacitor C1558 couples Z1509 to Z1510. Impedance Z1510, consisting of variable inductor L1510, trimmer C1510, C1559, C1560, and C1561, provides the 2- to 4-mc signals to the band 1 and 2 mixer-amplifier circuits and to meter M701 through switch S804. Crystal CR1505 rectifies the voltage applied to the meter, and C1562, C1563, R1519, and R1540 are the filter current limiting network for the meter circuit. Test points TP1522, TP1533, TP1509, and TP1510 provide access to the grid, cathode, and plate circuits for measurements.

57. Frequency Multiplier V1506

(fig. 46)

a. The frequency multiplier stage generates the injection frequencies for the mixer stages within the bands 3 through 5 mixer-amplifiers. Frequency multiplier V1506 is inoperative when the exciter-monitor compartment is set to the band 1 or band 2 frequencies. When an output frequency of 4.3 to 8.3 mc (band 3) or 8.3 to 16.3 mc (band 4) is required, V1506 functions as a tripler, multiplying the 2- to 4-mc output of the smo to a frequency range of 6 to 12 mc. When the exciter-monitor is set to band 5 (16.3 to 32.3 mc), V1506 multiplies the input frequency by a factor of 7, thereby producing an injection frequency within the 14- to 28-mc range.

b. The 2- to 4-mc input signal is coupled through C1575 and developed across R1533. When the band switch is set to position 1 or 2, switch S1505 opens the path to the +300-volt supply, and V1506 is inoperative. When the 3 or 4 position of S1505 is used, the plate of V1506 is returned to the +300-volt supply through tuned plate load Z1513 (consisting of variable inductor L1513, trimmer C1513, C1579, and C1580). Inductor L1513 is ganged to the FREQ-MC and FREQ-KC shafts and resonates Z1513 to any frequency within the 6- to 12-mc range. The output of Z1513 is coupled through positions 3 and 4 of S1506 (on positions 1 and 2, the control grid of V1507 is grounded) to the control grid of buffer amplifier V1507. Resistor R1534 is the screen grid voltage-dropping resistor, and C1576 is the screen grid bypass for V1506. Plate and screen supply decoupling is provided by R1535, C1577, and C1578.

c. When the band switch is set to position 5, the plate of V1506 is returned to the +300-volt supply through the wiper and contact 5 of S1505 and Z1514 (consisting of variable inductor L1514, C1581, and trimmer C1514). Inductor L1514 is ganged to the FREQ-MC and FREQ-KC controls and resonates Z1514 to any frequency between 14 to 28 mc. The 14- to 28-mc output of Z1514 is coupled through C1582 and C1584 to Z1515 in the grid circuit of V1507. Capacitors C1583 and C1582 function as an ac voltage divider and reduce the amplitude of the band 5 frequencies applied to Z1515 and V1507. Test points TP1513, TP1514, and TP1515 provide access to Z1513, Z1514, and Z1515 for measurements.

58. Buffer Amplifier V1507

(fig. 46)

a. Buffer amplifier V1507 isolates the frequency multiplier (par. 57) from loading effects of the mixers within the mixer-amplifier stages, and provides the required amplification to the 6- to 12-mc, and 14- to 28-mc frequencies.

b. When the band switch is placed in position 1 or 2, switch S1506 grounds the control grid of V1507. The plate circuit of V1507 is also disabled in positions 1 and 2, because switch S1507 removes the +300-volt supply from the plate. When the BAND switch is placed in position 3 or 4, switch S1506 couples the output of Z1513 to the grid of V1507. The Z1513 output is applied across the V1507 input network consisting of R1536, R1537, and C1587. A portion of the negative voltage that results from grid current flow is made available to test point TP1537 at the junction of R1536 and R1537. Tube V1507 amplifies the 6- to 12-mc signal and applies it to tuned plate circuit Z1516 (consisting of variable inductor L1516, trimmer C1516, C1590, C1591, and C1592) through switch S1507.

c. A portion of the 6- to 12-mc voltage at the junction of C1590 and C1591 is developed across R1540 and applied to mixer V1401 (par. 85) and to mixer V1504 (par. 61). The 6- to 12-mc output of Z1516 is coupled to another tuned circuit, Z1517 (consisting of variable inductor L1517, C1517,

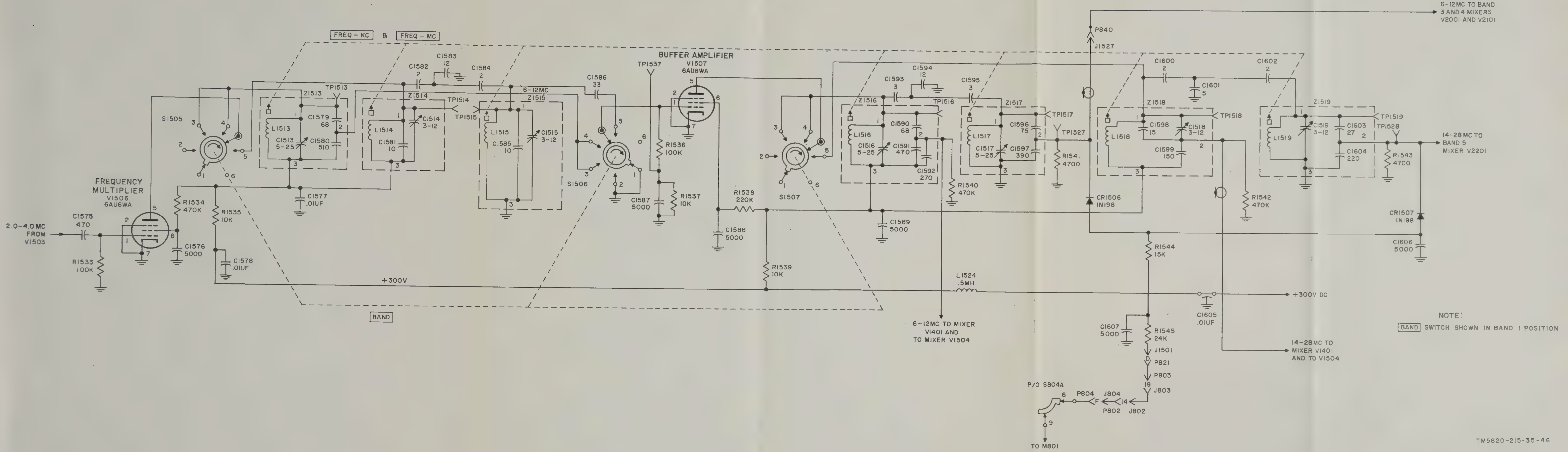
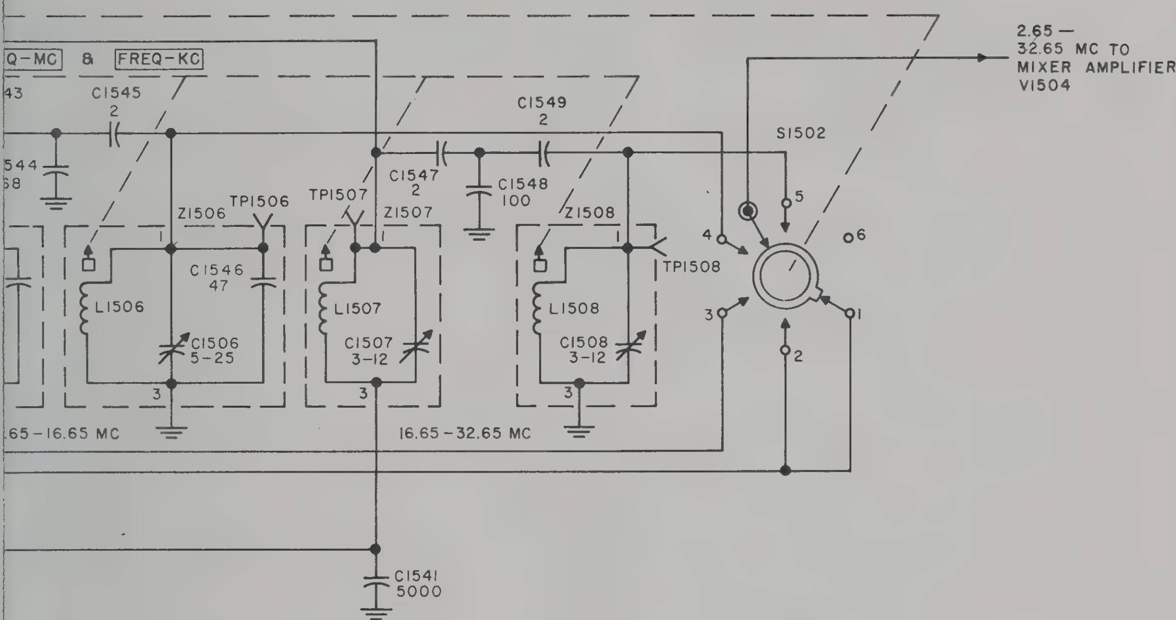


Figure 46. Frequency multiplier V1506 and buffer amplifier V1507, schematic diagram.



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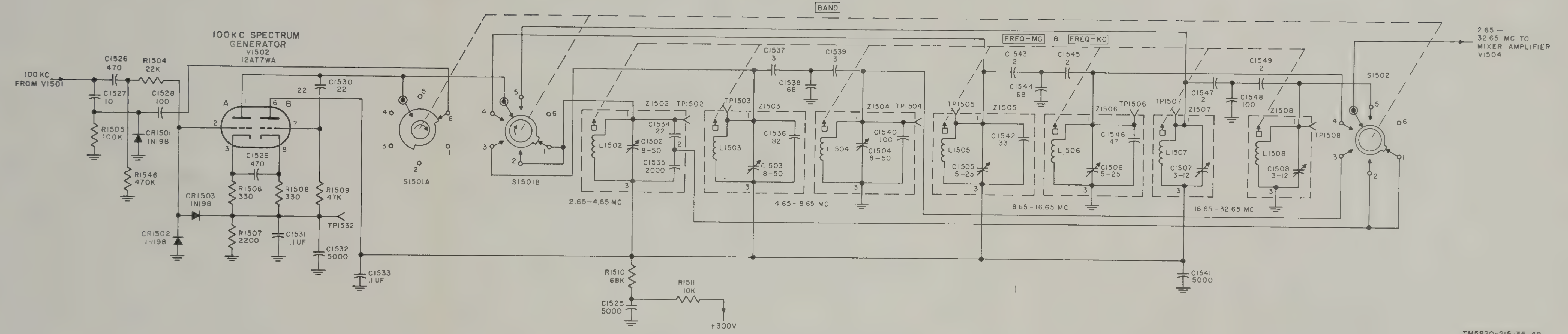

Figure 48. 100-kc spectrum generator, schematic diagram.

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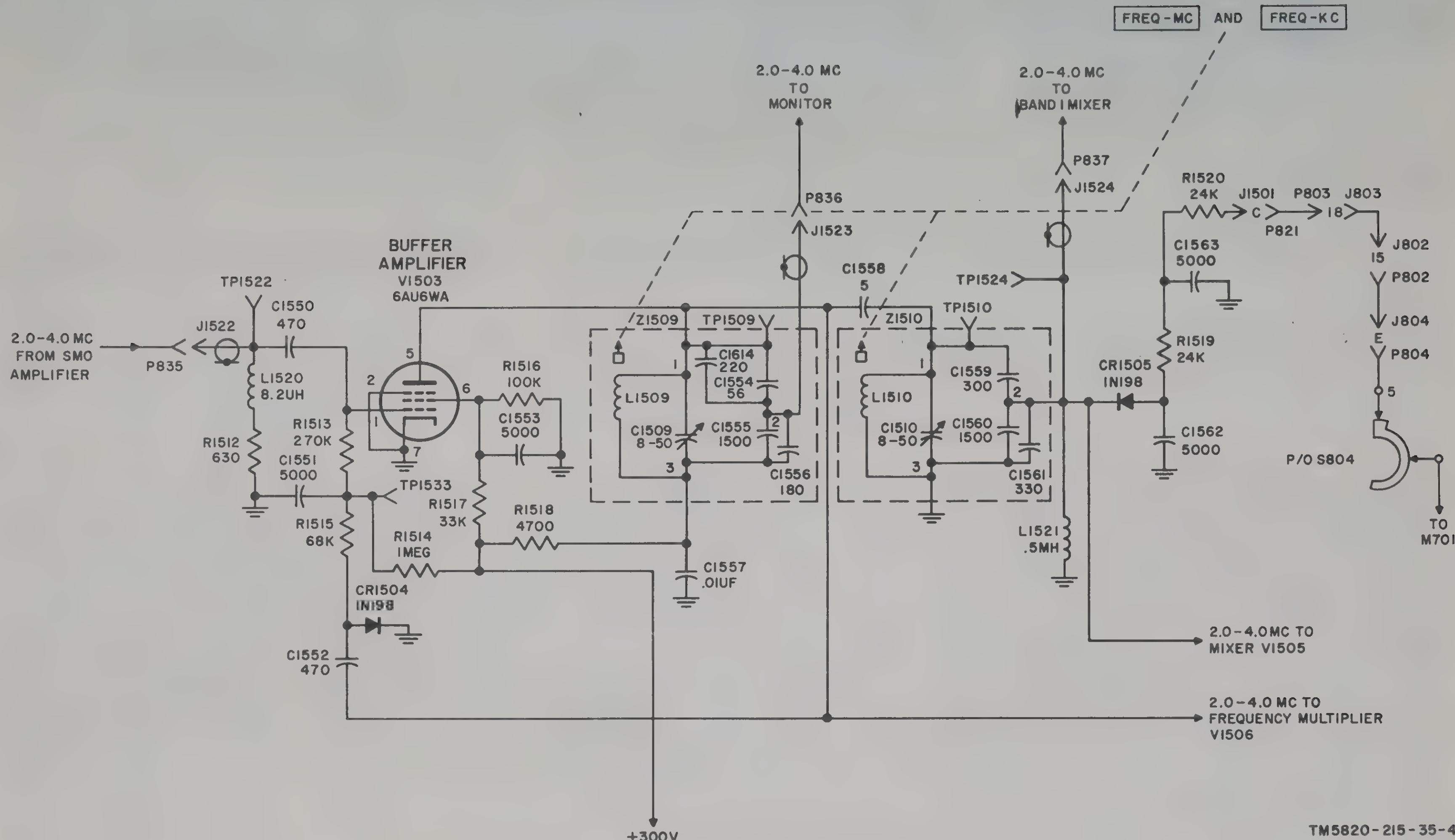


Figure 45. Buffer amplifier V1503, schematic diagram.

C1596, and trimmer C1597), through C1593 and C1595. Capacitors C1594 and C1593 serve as an ac voltage divider that reduces the overall amplitude of the RF voltage delivered to Z1517 through C1595. The voltage across Z1517 is applied to the band 3 or band 4 mixer V2001 (par. 51) or V2101 (par. 52). The voltage across Z1517 is also applied across R1541, rectified by CR1506, filtered, and current limited by R1544, C1606, R1545, and C1607 and applied through S804 to front-panel meter M801. Resistor R1538 is the screen grid voltage-dropping resistor and C1588 is the bypass. Plate and screen supply decoupling is provided by R1539 and C1589. Inductor L1524 is an RF choke in the +300-volt line. Inductors L1516 and L1517 are ganged to the FREQ-MC and FREQ-KC shafts and automatically tune Z1516 and Z1517 to the desired frequency within the 6- to 12-mc range. Test points TP1516, TP1517, and TP1527 provide access to Z1516 and Z1517 for measurements.

d. When the band switch is in position 5, switch S1506 (wiper and contact 5) couples the 14- to 28-mc signal from Z1515 (consisting of variable inductor L1515 and trimmer C1515 and C1585) to the grid of V1507. Switch S1507 (contact 5 and wiper) returns the plate to the +300-volt supply through Z1518 (consisting of variable inductor L1518, C1598, C1599, and trimmer C1518). A portion of the output of Z1518 is applied across R1542 and coupled to V1402 (par. 86) and to V1504 (par. 61). The 14- to 28-mc signal voltage across Z1518 is also coupled to capacitive voltage divider C1600 and C1601, and then to Z1519 through C1602. Impedance Z1519 consists of variable inductor L1519, trimmer C1519, C1603, and C1604. The 14- to 28-mc signal across Z1519 is applied across R1543 and then to mixer V2201 (par. 53) in the band 5 mixer-amplifier section. The metering circuit for the Z1519 output consists of rectifier CR1507, filter and current limiting circuit C1606, R1544, C1607, and R1545. The rectified current is applied through S804 to the front panel meter. Inductors L1515, L1518, and L1519 are ganged to the FREQ-MC and FREQ-KC controls and resonate the selected tuned circuits to the desired frequency within the 14- to 28-mc range. Test points TP1515, TP1518, and TP1519 provide access to Z1515, Z1518, and Z1519 for measurements.

59. 100-Kc Amplifier V1501

(fig. 47)

a. The smo RF chassis contains a frequency generating subchassis (consisting of V1501, V1502, V1504, and V1505) that accepts a 100-kc signal from the frequency standard compartment and produces accurate reference signals that are subsequently mixed with the output of the stabilized master oscillator and applied to the smo error detector circuit.

b. The 100-kc sine-wave input from the frequency standard compartment is coupled through C1520 and developed across R1501. This 100-kc signal is amplified by V1501 and applied across tuned plate load Z1501 (consisting of L1501, C1501, and C1523).

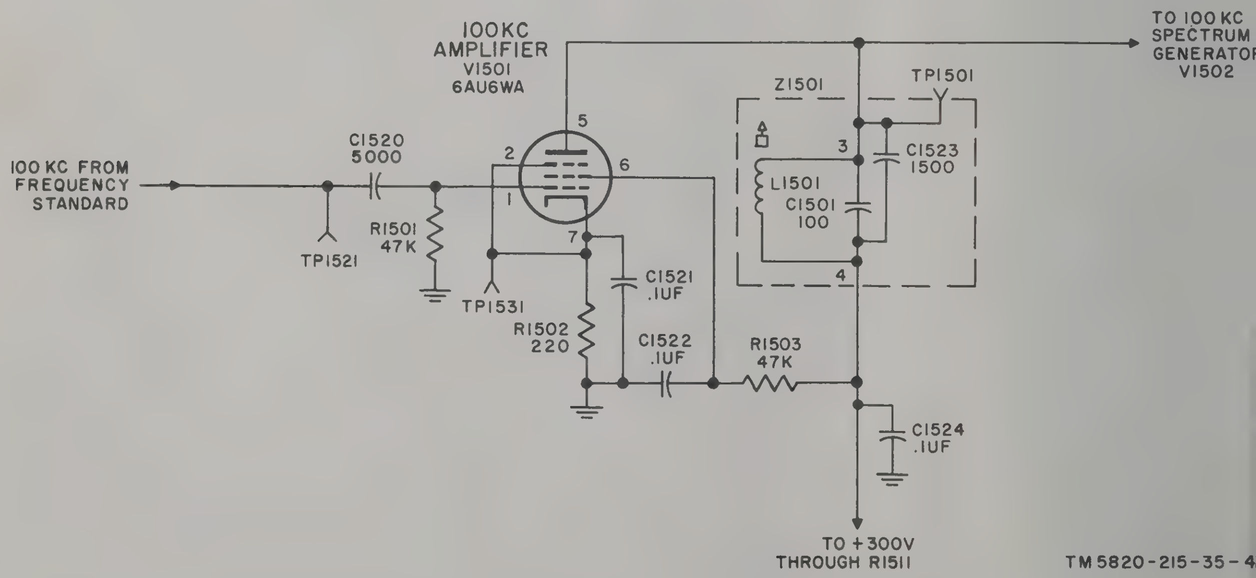


Figure 47. 100-kc amplifier V1501, schematic diagram.

nductor L1501 is adjusted during alignment only nd is sharply tuned to 100 kc. Cathode bias is provided by R1502 and C1521. Resistor R1503 is the creen grid voltage-dropping resistor and C1522 is he screen grid bypass. Capacitors C1524 and C1525 nd resistor R1511 decouple the plate and screen upply. The output of this stage is applied to 100-kc pectrum generator V1502 (par. 60). Test point TP1501 provides access to Z1501 for measurements. Test point TP1531 provides access for cathode voltage measurement.

60. 100-Kc Specrtum Generator V1502
(fig. 48)

a. The 100-kc sine-wave input from V1501 is applied to CR1502 and CR1503. These crystals clip he 100-kc input and generate harmonics in the 100-kc spectrum generator V1502 grid circuit. The output of V1502 is applied to the tuned circuit selected by the band switch. The individual tuned circuits are automatically tuned by the FREQ-MC nd FREQ-KC shafts which position tuning slugs within the individual tuned circuits.

b. The 100-kc input signal is coupled through C1526 and R1504 and applied to the grid of V1502A. Crystal CR1502 conducts during the negative excursion of the input signal and eliminates that portion of the 100-kc signal. Crystal CR1503 clamps he positive half of each cycle of the input signal o the value of dc voltage developed across R1507 nd C1531. This clipping action provides V1502 with a clipped *positive* input at a 100-kc rate that is ich in harmonic content.

c. Tube V1502 is a cathode coupled multivibrator which, in the no-signal condition, is prevented from oscillating by cathode-resistor bias developed across R1507. Normally, V1502B conducts because its grid s returned to the positive end of R1507. The grid of V1502A is returned to ground (through CR1502), nd the voltage drop across R1507 due to V1502B cathode current appears as cathode-resistor bias on V1502A. Each positive half of the 100-kc square wave drives V1502A into conduction. When V1502A conducts, the circuit oscillates at a frequency determined by the tuned circuits switched into the plate circuit of V1502A by the band switch. This action produces frequencies at integral multiples of 100 kc determined by the setting of the band switch and he frequency controls.

d. The 100-kc input signal is developed across C1527 and R1505. Capacitor C1528 and CR1501 are connected across the tuned circuit selected by the band switch. Crystal CR1501 is connected in such a manner that it conducts immediately after the input signal swings negative. When CR1501 conducts, it shunts the tuned circuit connected to the plate of V1502A. This damping action minimizes shock excitation of the tuned output circuit during the negative half of each input cycle. Damping action is unnecessary on band 5, and switch S1501A disconnects this circuit to minimize shunt capacity across Z1507 and Z1508 (the band 5 tuned circuits).

e. When the band switch is placed to band 1 or 2, the plate of V1502A is coupled to Z1502 (consisting of variable inductor L1502, trimmer C1502, and C1534 and C1535) through contact 1 or 2 and the wiper of S1501B. Switch S1501A, through the wiper and contact 6, places CR1501 across the tuned circuit. The 2.65- to 4.65-mc output of Z1502 is coupled from the junction of C1534 and C1535 and applied to mixer-amplifier V1504 through contact 1 or 2 and the wiper of S1502.

f. When this circuit is used to generate frequencies within the 4.65- to 8.65-mc spectrum, switch S1501B (contact 3 and wiper) connects the plate of V1502A to Z1503 (consisting of variable inductor L1503, trimmer C1503, and C1536). To improve the selectivity within this frequency range, the output of Z1503 is coupled through capacitive voltage divider C1537, C1538, and C1539 to Z1504 (consisting of variable inductor L1504, trimmer C1504, and C1540). The RF voltage across Z1504 is coupled to V1504 through contact 3 and the wiper of S1502.

g. The action of this circuit on bands 4 (8.65 to 16.65 mc) and 5 (16.65 to 32.65 mc) is comparable to that described for band 3 (*f* above). Tuned circuits Z1505 and Z1506 are used for band 4; tuned circuits Z1507 and Z1508 are used for band 5. The output of these tuned circuits is coupled through the appropriate contacts of S1502 to mixer-amplifier V1504 (par. 61).

h. Plate decoupling is provided by C1533, C1541, R1510, C1525, and R1511. The cathode ends of resistors R1506 and R1508 are interconnected for RF by capacitor C1529. This places both cathodes of the tube at the same RF potential for multivibrator operation of V1502. Capacitor C1532 bypasses any noise that may be introduced into TP1532. Various test points connected to the tuned circuits and V1502 provide access for measurements.

61. Mixer-Amplifier V1504

(fig. 49)

a. Mixer-amplifier V1504 functions as an amplifier when the band switch is set on band 1 or band 2, and as a mixer on bands 3 through 5. On all bands, the output of this stage is always in the frequency range of 2.65 to 4.65 mc. The exact output frequency depends upon the setting of the FREQ-MC and FREQ-KC controls, which position the tunable slugs within the tuned circuits.

b. On bands 1 and 2, the injector grid (pin 7) is grounded through the wiper and contact 1 or 2 of S1503. The 2.65- to 32.65-mc signal from V1502 is applied to the control grid (pin 1) of V1504. When the band switch is set to either band 1 or 2, the input to the control grid (pin 1) is in the frequency range of 2.65 to 4.65 mc. The selected frequency is amplified by V1504 and applied across Z1511 (consisting of variable inductor L1511, trimmer C1511, and C1567), coupled through C1568, and applied across Z1512 (consisting of variable inductor L1512, trimmer C1512, and C1569). The 2.65- to 4.65-mc signal across Z1512 is applied to mixer V1505 (par. 62).

c. When the band switch is set to band 3, a 2- to 4-mc signal from V1503 (par. 56) is applied to the injector grid (pin 7) of V1504. Another signal from Z1504 (fig. 48), within the frequency range of 4.65 to 8.65, is applied to the control grid (pin 1). The two signals are heterodyned and a difference frequency, within the range of 2.65 to 4.65 mc, is applied across Z1511.

d. When the band switch is set to position 4, a 6- to 12-mc frequency from V1507 (par. 58) is mixed with an 8.65- to 16.65-mc signal from Z1506 (fig. 48) to produce a difference frequency withi the range of 2.65 to 4.65 mc. On position 5, a 14 to 28-mc signal from V1507 is mixed with a 16.65 t 32.65 signal from Z1508 (fig. 48) to produce the sam frequency range of 2.65 to 4.65 mc.

e. Cathode bias for V1504 is provided by R152 and C1564. Resistor R1522 is the grid resistor fo the injector grid and R1524 is the grid resistor fo the control grid. Resistor R1525 is the screen gri voltage-dropping resistor and C1565 is the scree grid bypass. Plate and screen supply decoupling i provided by C1566 and R1530. Resistor R152 dampens Z1511 and lowers the Q of the tuned circui

62. Mixer V1505

(fig. 49)

a. Mixer V1505 is a dual-triode tube that accept a 2.65- to 4.65-mc signal from Z1512 and mixes with a 2- to 4-mc signal from V1503. The outpu of this stage (difference frequency of the two inputs is coupled through C1572 and applied to a 600- t 700-kc tuned circuit within the smo error detecto subchassis.

b. The 2.65- to 4.65-mc signal from Z1512 is ap plied through parasitic oscillation suppressor R152 developed across R1528, and applied to the pin control grid of V1505. The 2- to 4-mc signal fro V1503 is coupled through C1570, developed acros the impedance consisting of R1531 and C1571, an applied to the pin 2 control grid. Inductor L1522 the plate load, and R1532 and C1573 provide plat decoupling. Mixer action is provided by R1529. In ductor L1623 and C1574 provide additional R filtering in the B+ line.

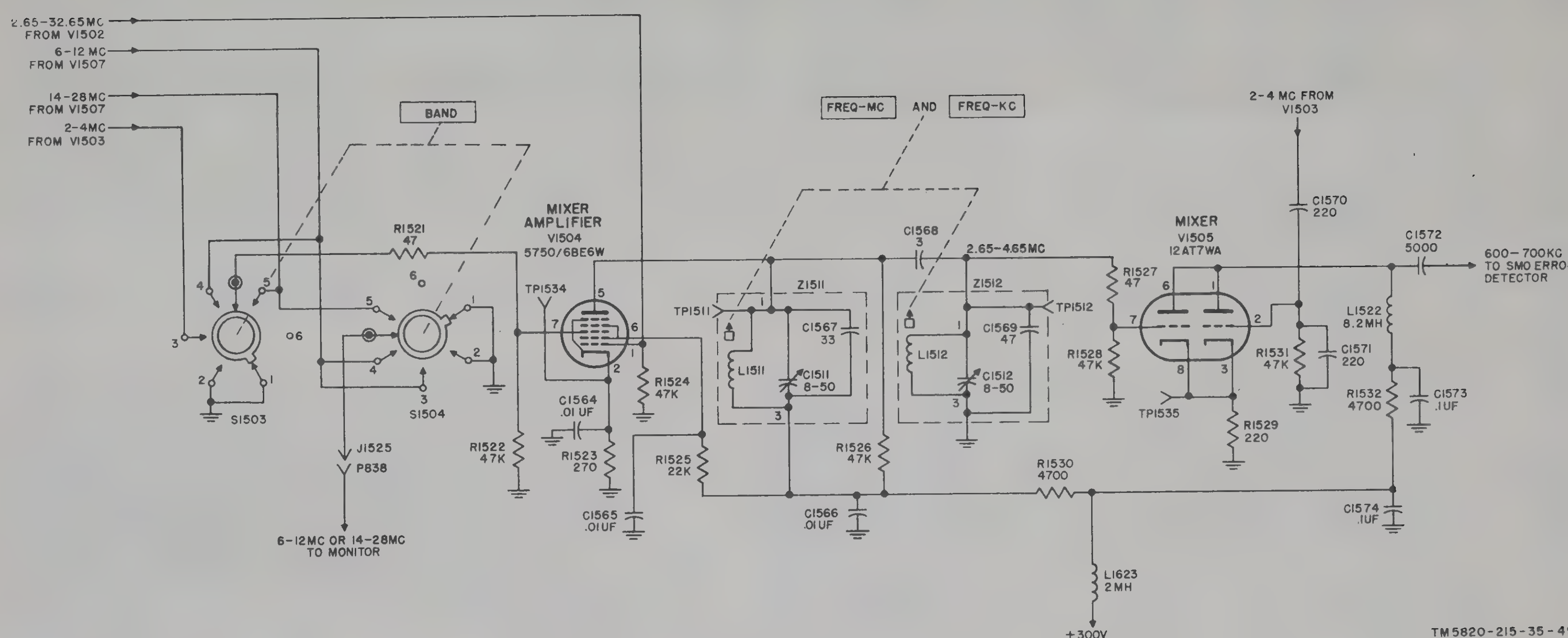


Figure 49. Mixer-amplifier V1504 and mixer V1505, schematic diagram.

Section III. INTERPOLATION OSCILLATOR, SMO ERROR DETECTOR, AND 0.5-KC SPECTRUM DETENT

63. General

The smo error detector section produces an smo control current the amplitude and direction of which are indicative of the amount and direction of frequency error within the stablized master oscillator circuit (par. 54). This current is supplied to a control winding within the tuned circuit of smo V1101. The smo error detector functions by mixing the 600–700 kc (containing the smo frequency error) from V1505 (par. 62) with the output of the interpolation oscillator (350–450 kc) and applying the resultant frequency (250 kc) to a frequency discriminator. The error voltage output of the frequency discriminator varies the smo control current to correct the smo frequency error. Any frequency error within the interpolation oscillator circuit is compensated by a correction frequency from the 0.5-kc spectrum detent stages (pars. 66–71). This action prevents the smo error detector from feeding a correction current to the smo that could be the result of an error within the interpolation oscillator circuit. Paragraph 6*c* and figure 5 cover the block diagram theory of the interpolation oscillator, the smo error detector, and the 0.5-spectrum detent; paragraphs 64 through 71 cover these stages in detail.

64. Interpolation Oscillator V1001
(fig. 50)

a. The interpolation oscillator produces a range of frequencies between 350–450 kc. The circuit uses a pentode-type tube in which the cathode, control grid, and screen grid are connected as a series-fed Hartley oscillator that is electron-coupled to the plate circuit. The exact output frequency of the stage is determined by the setting of the FREQ-KC control which positions a tuning slug within L1001.

b. The tank circuit of the oscillator consists of toroid L1002, variable inductor L1001, trimmer L1003, and capacitors C1001 through C1003. The oscillator feedback loop contains screen grid bypass C1006 and the lower half of toroid L1002. The 350–450 kc tank circuit output is coupled through C1004 and applied to the control grid. Grid leak bias is furnished by R1001 and C1004. All the components within the oscillator tank circuit are housed in a compartment that is maintained at constant temperature by heater HD1001. Thermostat-type switch S1001 controls the heater circuit temperature and C1008 prevents switch arcing.

c. The output of V1001 is developed across plate load resistor R1003 and coupled to the next stage through C1005. Resistor R1002 is the screen grid voltage-dropping resistor.

65. Cathode Follower V1002
(fig. 50)

a. Cathode follower V1002 functions as a buffer and an impedance-matching device. The two V1002 outputs are applied to mixer V1701 in the smo error detector and mixer V1203 in the 0.5-kc spectrum detent subchassis.

b. The 350–450 kc input signal is applied across the paralleled combination of R1004 and C1009 and directly to both V1002 grids. The cathode follower outputs are developed at the individual cathodes which return to ground through the grid input networks of V1203 (par. 68) and V1701 (par. 72). The plate circuit of V1002 is returned directly to the +210-volt line. Capacitor C1007 places the V1002 plates at ac ground.

66. Square Wave Amplifier V1201
(fig. 51)

a. Square wave amplifier V1201 is the first of six stages that comprise the 0.5-kc sectrum subchassis. This group of stages produces a signal that provides correction for frequency errors within the interpolation oscillator (par. 64). The square wave amplifier is preceded by a full-wave clipper network in its grid circuit that clips the positive and negative peaks from the 1-kc sine-wave input from the frequency standard compartment. Tube V1201 amplifies this clipped signal and applies it to 1-kc spectrum generator V1202. Square wave amplifier V1201 is inoperative when the 0.5 KC LOCK is placed in the OFF position because switch S803, contacts 1 and 3, returns the control grid to —105 volts, biasing the tube to cutoff.

b. The 1-kc input signal is applied to diode clipper CR1201 and CR1202 through driving source resistor R1201 and capacitor C1201. Assume that a negative half-cycle is applied to the clipper network. Diode CR1202 conducts charging C1202 negatively with respect to ground. When the input cycle swings

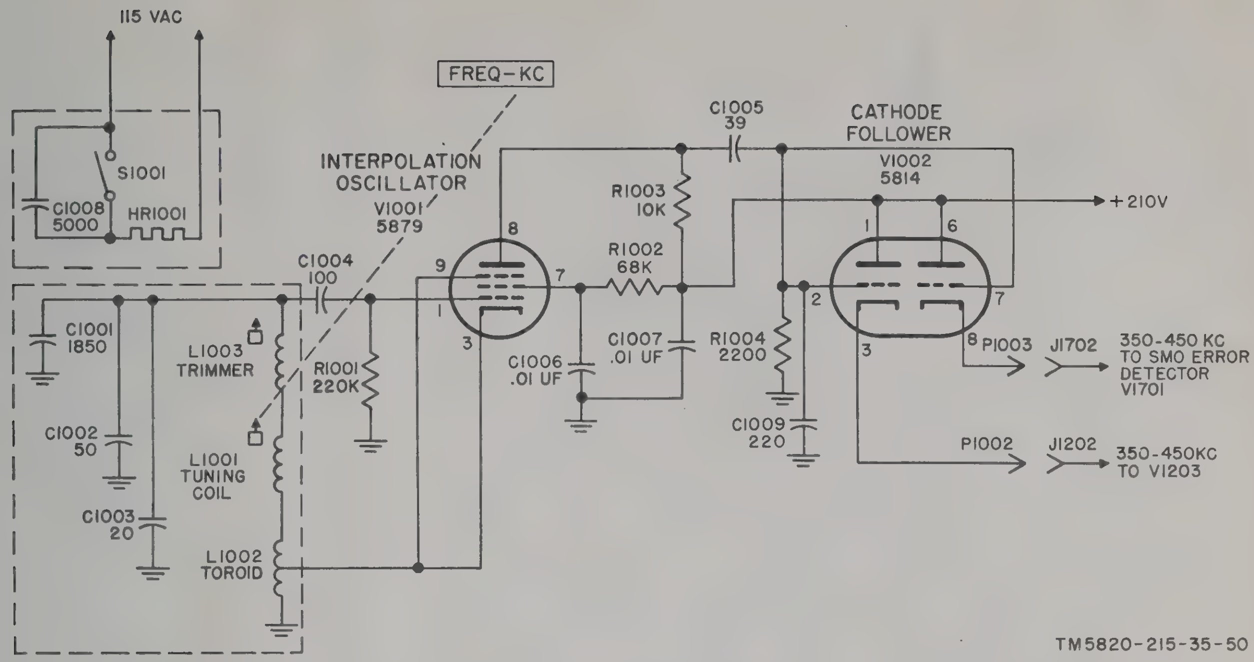


Figure 50. Interpolation oscillator V1001 and cathode follower V1002, schematic diagram.

positive, C1202 discharges through R1203 and R1204; the voltage drop across R1203 reverse biases CR1201. During this period the input signal is developed across the resistive network of R1202 through R1204. When C1202 is discharged, bias is removed from CR1201, and CR1201 conducts, shorting R1202. This action charges C1202 positively with respect to ground and effectively reduces the peak amplitude of the positive half-cycle applied to V1201. When the input signal swings negative, C1202 discharges through R1203 and biases CR1202. During this period, the negative input is developed across R1202 through R1204. When C1202 is discharged, the biasing voltage is removed from CR1202, and CR1202 conducts and shorts R1202. This action again charges C1202 negatively with respect to ground and reduces the peak amplitude of the negative half-cycle.

c. The clipped input signal is amplified by V1201, applied across plate load resistor R1206, and coupled through C1205 to the grid of 1-kc spectrum generator V1202. Resistor R1205 is the screen grid voltage-dropping resistor and C1203 is the screen grid bypass. Plate decoupling is provided by R1207, C1204, and C1247.

67. 1-Kc Spectrum Generator V1202
(fig. 51)

a. The 1-kc square wave input from V1201 is clipped again by crystal diodes in the grid circuit of 1-kc spectrum generator V1202. The generated harmonics of the 1-kc signal trigger V1202, which operates as a multivibrator. Tuned network Z1201, in the V1202 output circuit, is mechanically linked to the FREQ-KC control and is tuned from 595-695 kc. The output of this stage is applied to mixer V1203.

b. The 1-kc square wave is coupled through C1205 and applied across the grid input network of R1208, CR1203, and CR1204. Crystal diode CR1203 conducts during the negative half-cycle of the input signal and eliminates that portion of the 1-kc input. Crystal CR1204 clamps the positive half-cycle to a peak amplitude determined by the dc voltage developed across R1209 and C1207. This clipping action provides V1202 with a clipped positive input at a 1-kc rate that is rich in harmonic energy.

c. Tube V1202 is a cathode-coupled multivibrator which, in the no-signal condition, is prevented from oscillating by cathode bias developed across R1209. Normally, V1202B conducts because its grid is returned to the positive end of R1209. The grid of V1202A is returned to ground through R1208, and the voltage drop across R1209, due to V1202B cathode current, appears as cathode bias on V1202A cutting this tube section off. Each positive half of the 1-kc square wave drives V1202A into conduction. When V1202A conducts, the circuit oscillates at a frequency at integral multiples of 1 kc between 595–695 kc. The exact frequency of oscillation is de-

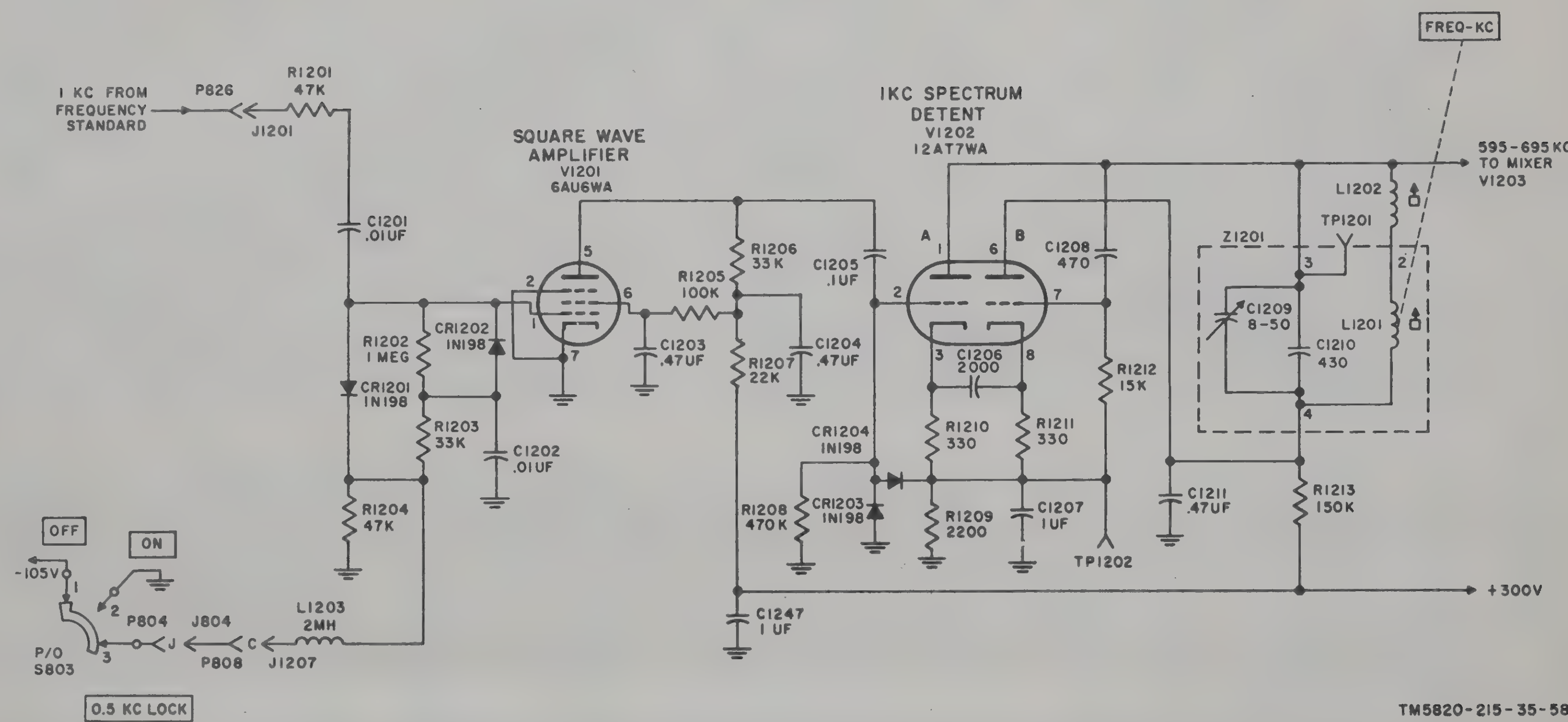
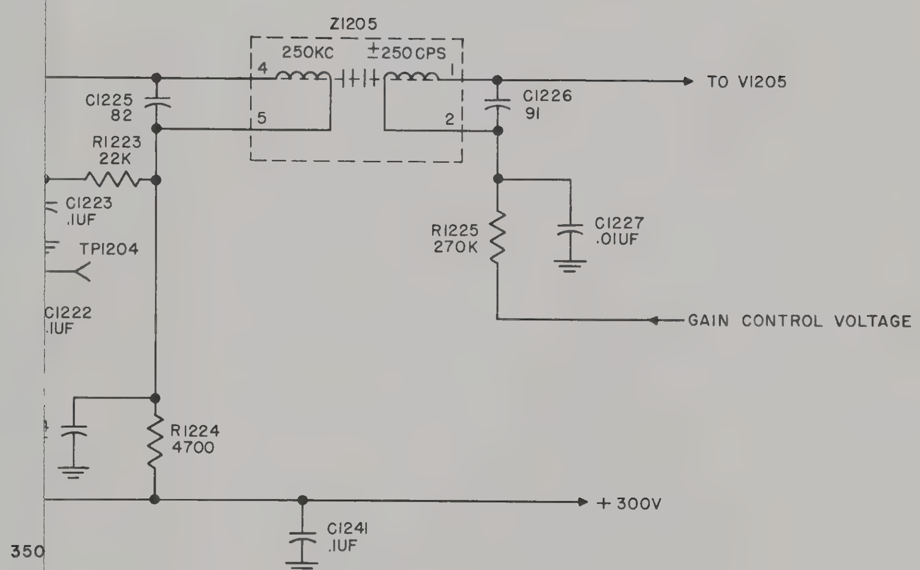


Figure 51. Square wave amplifier V1201 and 1-kc spectrum generator V1202, schematic diagram.



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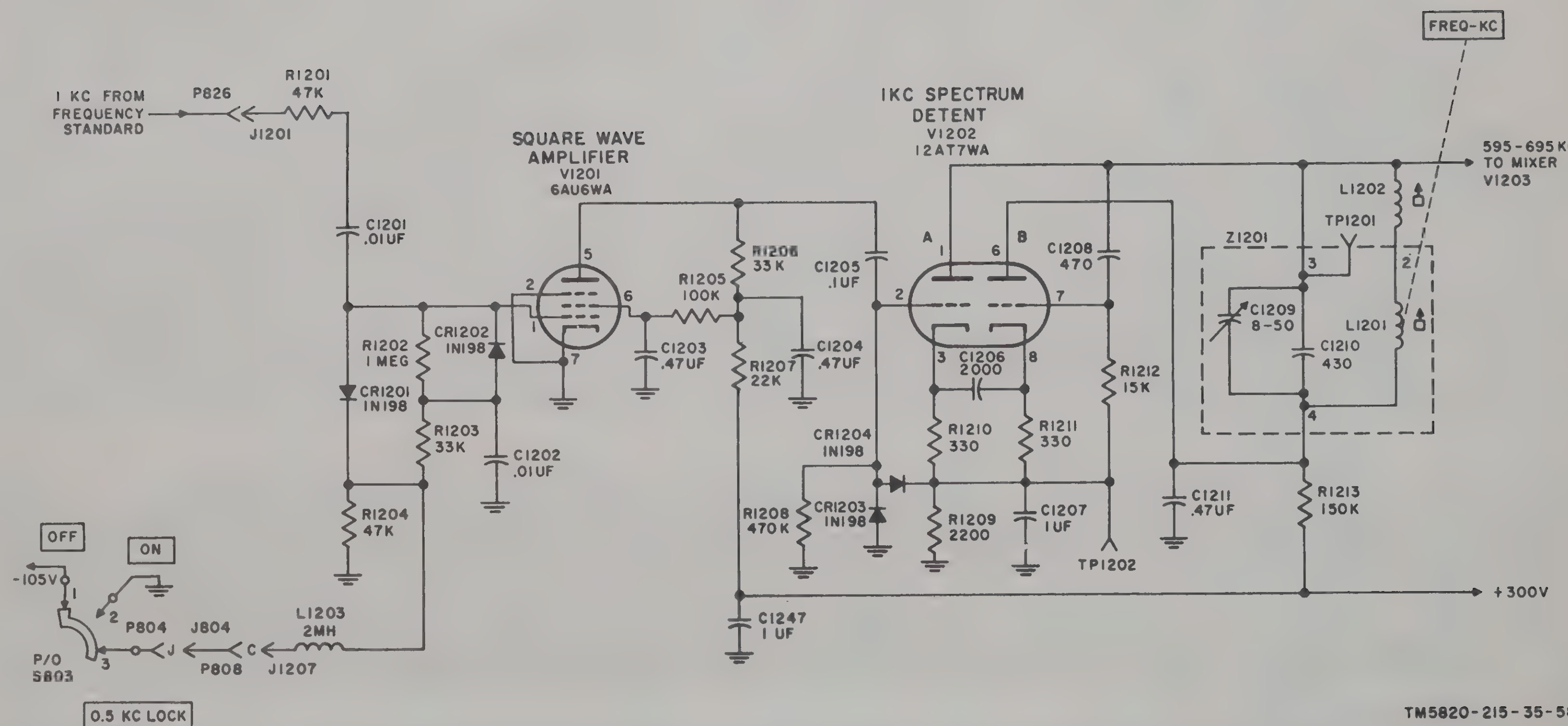


Figure 51. Square wave amplifier V1201 and 1-kc spectrum generator V1202, schematic diagram.

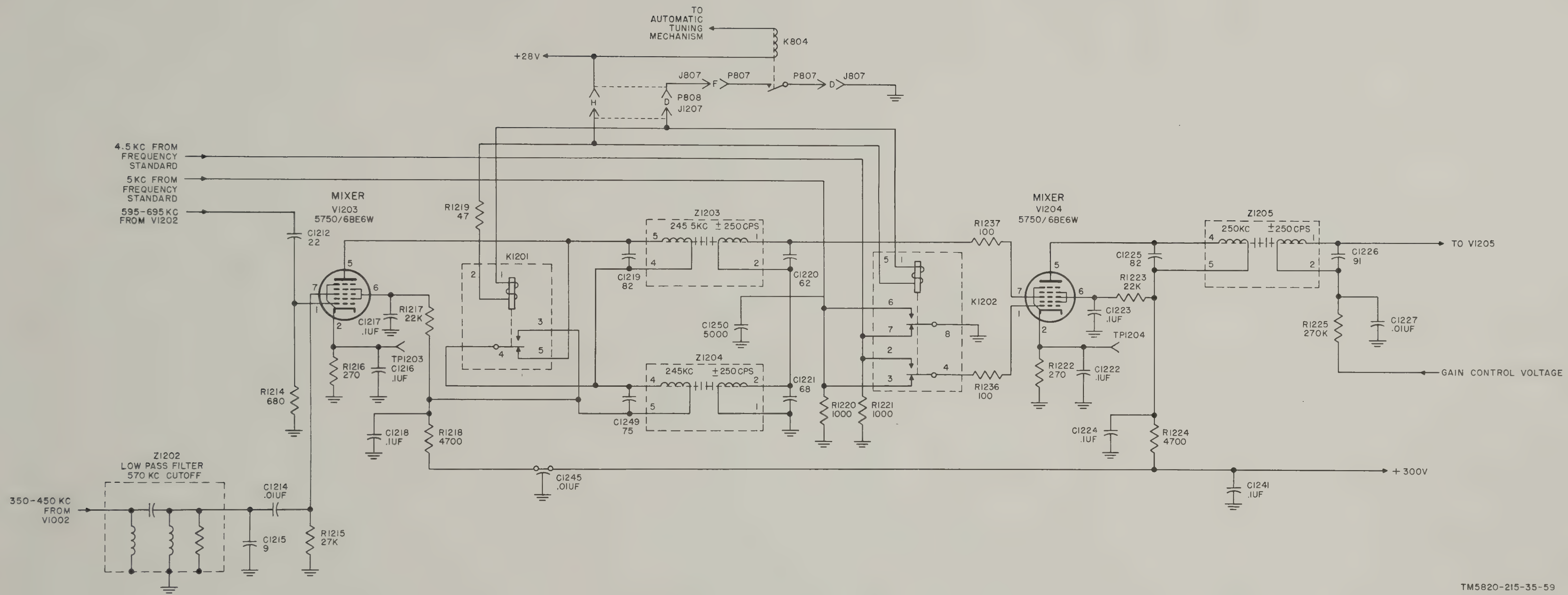


Figure 52. Mixer stages V1203 and V1204, schematic diagram.

termined by the setting of the FREQ-KC control, which positions the tuning slug within L1201.

d. Plate decoupling for the stage is provided by R1213 and C1211. The cathode ends of resistors R1210 and R1211 are interconnected for RF by C1206. This places both cathodes at the same RF potential for multivibrator operation of V1202. Plate load Z1201 consists of variable inductor L1201, trimmer coil L1202, and trimmer capacitors C1209 and C1210. The output of Z1201 is coupled to mixer V1203.

68. Mixer V1203
(fig. 52)

a. Mixer V1203, a type 6BE6W tube, receives two signal inputs. One is the 595–695-kc signal from 1-kc spectrum generator V1202 and the other is the 350–450-kc signal from the interpolation oscillator subchassis. Mixer V1203 heterodynes these two frequencies and produces a difference frequency of either 245 kc or 245.5 kc, depending upon whether the exciter-monitor is set to an even 0.5-kc point or an odd 0.5-kc point. When the FREQ-KC dial is set to an odd 0.5-kc point, a difference frequency of 245.5 is developed across Z1203. When the FREQ-KC dial is set to an even 0.5-kc point, the mixer output of 245 kc will be developed across Z1204. The output of the selected filter (Z1203 or Z1204) is applied to the next stage.

b. The 595–695-kc signal from 1-kc spectrum generator V1202 is coupled through C1212, developed across R1214, and applied to the control grid (pin 1) of V1203. The 350–450-kc signal is passed through low-pass filter Z1202, coupled through C1214, developed across R1215, and applied to injector grid (pin 7) of V1203. The two signals are mixed by V1203 and the difference frequency is applied to Z1203 or Z1204, depending upon whether relay K1201 is energized or not. Relays K1201 and K1202 (par. 69) are energized through the action of relay K804; K804 is energized by the automatic tuning mechanism at 0.5-kc detent points. When the exciter-monitor is operating at an even 0.5-kc point, relay K1201 is not energized. When K1201 is not energized, contacts 4 and 5 short out Z1203 and 245 kc from V1203 is applied through these contacts to 245-kc tuned circuit Z1204. When the exciter-monitor is set to an odd 0.5-kc point, relay K1201 is energized, contacts 3 and 4 short out Z1204 and the 245.5-kc signal is applied to 245.5-kc tuned circuit Z1203. The 245.5-kc or 245-kc output of V1203 is applied to the injector grid of mixer V1204.

c. Resistor R1217 is the screen grid voltage-dropping resistor and C1217 is the screen grid bypass. Resistor R1216 and RF bypass capacitor C1216 form the self-biasing network in the V1203 cathode circuit. Plate decoupling is provided by R1218 and C1218. Capacitor C1245 is an additional filter in the +300-volt line.

69. Mixer V1204
(fig. 52)

a. The frequency of the input to the control grid, pin 1 of mixer V1204, is selected by relay K1202. When this relay is deenergized, 245 kc from Z1204 is applied to the injector grid (pin 7) of V1204 (since K1201 is deenergized at the same time) and 5 kc from the frequency stadnard compartment is coupled through contacts 3 and 4 of K1202 and applied to the control grid. The two signals mix in V1204 and a sum frequency of 250 kc is developed across Z1205. When relay K1202 and K1201 are energized, 245.5 kc from Z1203 is applied to the injector grid and 4.5 kc from the frequency standard is coupled through contacts 2 and 4 of K1202 and applied to the control grid. The two signals mix in V1204 and produce a sum frequency of 250 kc across Z1205. Regardless of whether the exciter-monitor is set on an odd or even 0.5-kc point, the output of this stage is always 250 kc.

b. Resistor R1221 is the grid resistor for the 4.5-kc input and R1220 is the grid resistor for the 5-kc input. Resistors R1236 and R1237 are parasitic suppressors. Cathode bias is provided by R1222 and C1222. Resistor R1223 is the screen grid voltage-dropping resistor and C1223 is the screen grid bypass. Plate decoupling is provided by R1224 and C1224. Capacitor C1241 is an additional filter in the +300-volt line. The 250 kc at the output of Z1205 is coupled to first 250-kc amplifier V1205. Resistor R1225 and capacitor C1227 make up a filter network that returns the grid of the next stage (V1205) to a gain control voltage.

70. First 250-Kc Amplifier V1205
(fig. 53)

First 250-kc amplifier V1205 amplifies the 250-kc input from Z1205 and applies its output to the second 250-kc amplifier. The gain of V1205 is controlled by a gain control voltage obtained from S4404 on the band switch. The gain control voltage

is the bias on V1205 and maintains the output of this stage at a constant amplitude. Capacitor C1229 is a screen grid bypass and resistors R1227 and R1228 make up a voltage divider to set the screen grid voltage. Grid bias is developed across R1226 paralleled by RF bypass C1228. Resistor R1229 is the plate load for V1205, and C1230, together with R1230, makes up a plate and screen supply decoupling neawork. The amplified 250-kc output of this stage is applied through C1232 to the grid of second amplifier V1206.

71. Second 250-Kc Amplifier V1206

(fig. 53)

a. The 250-kc input from V1205 is applied across the grid input network consisting of R1232, R1231, R1204, C1251, C1242, and L1203. When 0.5 KC LOCK switch S803 is set to OFF, the control grid of V1206 is returned to —105 volts and the tube is biased to cutoff. When the 0.5 KC LOCK is set to ON, the 250-kc signal is amplified by V1206, developed across plate load Z1206 (consisting of adjustable coil L1206 and capacitors C1236 through C1239), and applied to the next stage through the contacts of relay K1203.

b. The coil of K1203 is connected in series with the plate and screen grid return to the +300-volt supply. When the 0.5 KC LOCK is set to ON, V1206 conducts and the plate and screen grid current through the coil of K1203 energizes the relay. This action closes contacts 2 and 4 of K1203 and 250 kc from Z1206 is applied to V1705 (par. 76) through C1240. When the 0.5 KC LOCK switch is set to OFF, V1206 is biased to cutoff, the plate and screen grid current drops to zero, and relay K1203 is deenergized. Contacts 3–4 and 7–8 of relay K1203 close and 250 kc from the frequency standard is fed through these closed contacts and coupled through C1240 to V1705. In the ON position of the 0.5 KC LOCK switch, the 250 kc that contains the interpolation oscillator error is applied to V1705. When the 0.5 KC LOCK switch is set to OFF, 250 kc from the frequency standard compartment is coupled to V1705.

c. Cathode bias for V1206 is furnished by R1233 and C1233. Resistor R1234 is a screen grid voltage-dropping resistor and C1234 is the screen grid bypass. Plate decoupling is provided by R1235, the relay coil, and C1235. Inductor L1204 is an additional filter in the B+ line. Test points TP1205, TP1207, and TP1206 provide access for cathode and plate measurements.

72. Mixer V1701

(fig. 54)

a. Mixer V1701 is the first of nine stages within the smo error detector subchassis. This subchassis accepts input signals from the smo RF section, the interpolation oscillator, and the 0.5-kc spectrum detent. It produces an output current that provides frequency correction to the smo unit. Two input signals are applied to mixer V1701. One is a 600–700-kc signal from V1505 (par. 52) and the other is the 350–450-kc signal from interpolation oscillator cathode follower V1002 (par. 65). The two signals are mixed in the dual triode and the difference frequency of 250 kc is applied to plate load Z1703.

b. The 600–700-kc signal is coupled through band-pass filter Z1701 and applied to the control grid of V1701A through parasitic suppressor resistor R1701. The 350–450-kc signal is passed through low-pass filter Z1702 (which rejects harmonics of the 350–450-kc interpolation oscillator), coupled through C1701, and developed across grid resistors R1705 and R1706. The RF voltage across these resistors is applied to the control grid of V1701B through parasitic suppressor resistor R1703. The junction of grid resistor R1705 and R1706 is returned to a contact on relay K1701. The coil of K1701 is normally energized because it is connected in series with R1727 across the +300-volt supply. When the smo unit is going through a tuning cycle (or being tuned manually), smo disabling relay K803 is energized. This action grounds the coil of K1701 and deenergizes the relay. The junction of R1705 and R1706 is then returned to —105 volts, V1701B is biased beyond cutoff, and the mixer is disabled during the tuning cycle. Band-pass filter Z1703 in the plate circuit of the still conducting half of the stage (V1701A) cannot pass the 570–730-kc signal.

c. The 250-kc output of mixer V1701 is developed across band-pass filter Z1703, coupled through C1705, and applied to V1702. Mixing action for this stage is provided by common cathode resistor R1702. Plate decoupling is provided by C1702, R1704, and C1703. Resistor R1727 limits the current through the coil of K1701. Test points TP1701, TP1702, TP1703, and TP1704 provide access for cathode and grid voltage measurements.

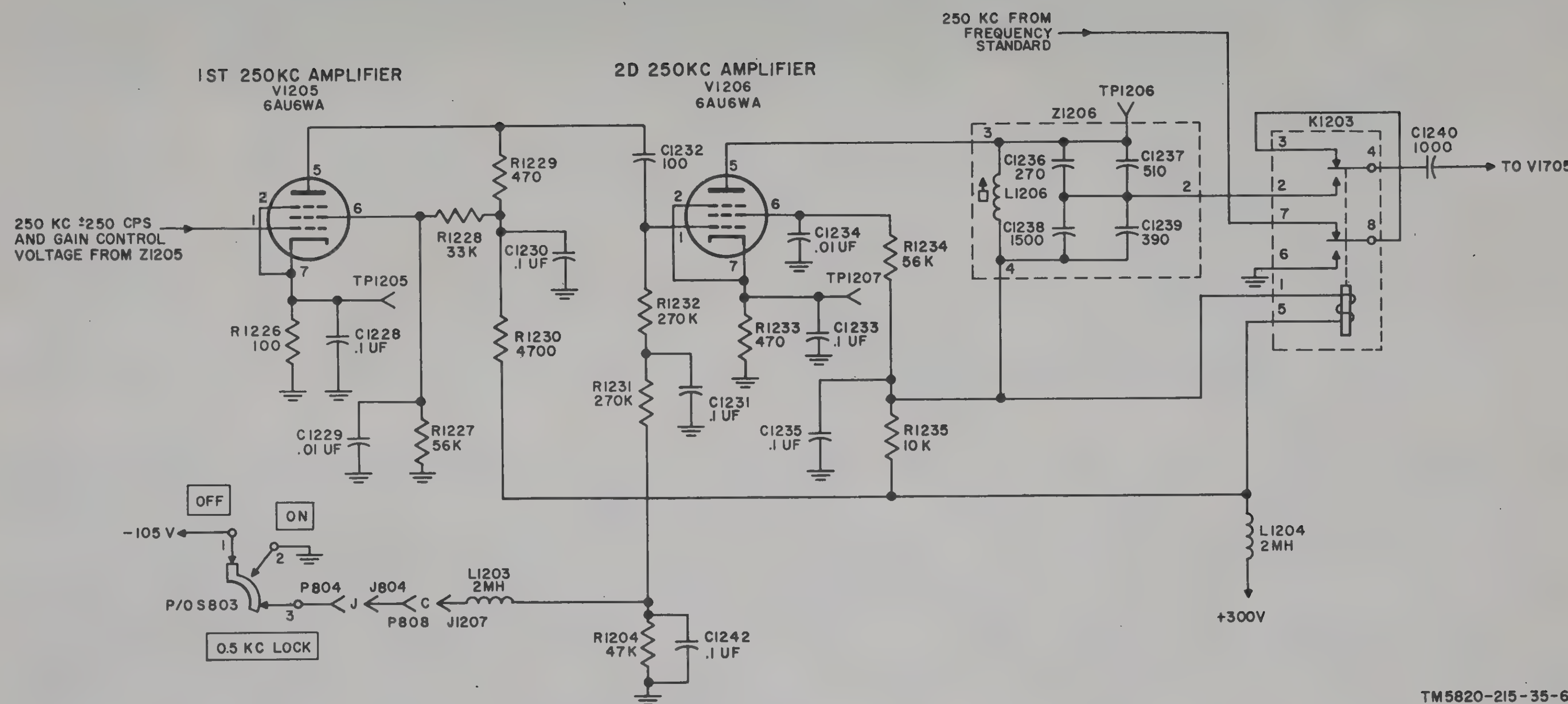


Figure 53. 250-kc amplifiers V1205 and V1206, schematic diagram.

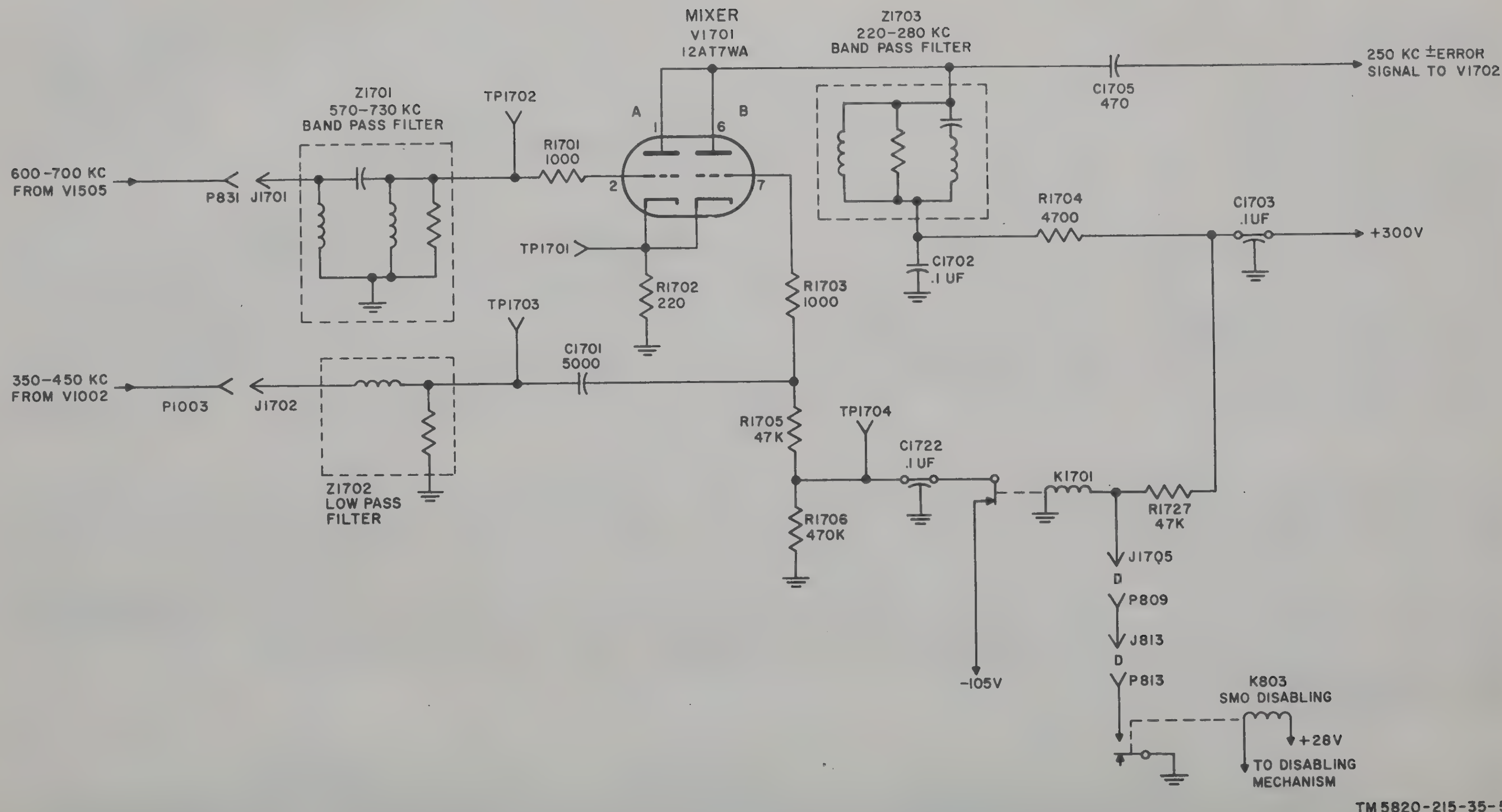


Figure 54. Mixer V1701, schematic diagram.

73. Limiter Amplifiers V1702 and V1703
(fig. 55)

a. The 250-kc signal (± smo frequency error) is amplified by the two limiter amplifier stages and coupled to buffer amplifier V1704A, the frequency discriminator (par. 75), and the phase detector (par. 78). A delayed automatic gain control (agc) voltage is applied to the control grids of the limiter amplifiers to minimize gain variations in these stages.

b. Crystal diode CR1701 rectifies the 250 kc appearing across the secondary of Z1704 and applies this voltage as agc to both limiter control grids. Crystal diode CR1709 is connected in series with R1711 to the +210 line and supplies the delay voltage for the agc line. The delay voltage delays the buildup of negative agc voltage until the Z1704 output reaches a predetermined level. Current rectified by CR1701 also flows through R1713 to meter M803.

c. The 250-kc input is amplified by first limiter amplifier V1702 and applied across the plate load consisting of R1710, L1701, and C1708. The output of this stage is coupled through C1707 to the grid of the second limiter amplifier. Capacitor C1706 is the screen grid bypass. Voltage-divider resistors R1708 and R1709, connected between ground and +300 volts, set the screen grid potential.

d. The 250 kc from V1702 is developed across grid resistor R1712 and applied to the grid of second limiter amplifier V1703. Tube V1703 amplifies the 250 kc and applies it to the next stage through bandpass filter Z1704, the primary of which is in the plate circuit of V1703. Capacitor C1710 is the screen grid bypass. Voltage-divider resistors R1746 and R1716, connected between ground and +300 volts, set the screen grid voltage. Capacitor C1711 is a filter in the +210 line, and C1709, R1714, and C1712 form the agc filter for CR1701. The 250-kc signal voltage across Z1704 is applied to frequency discriminator CR1702 (par. 75), phase detector CR1708 (par. 78), and buffer amplifier V1704A.

74. Buffer Amplifier V1704A and Rectifier CR1703
(fig. 55)

a. The 250-kc input signal from second limiter amplifier V1703 is coupled through C1715, developed across grid resistor R1747, and applied to the grid of buffer amplifier V1704A. Cathode bias is provided by R1748, R1749, and C1743. Resistor R1749 is variable and is used to adjust the bias, and thereby controls the gain of this stage.

b. The output of V1704A is developed across plate load R1754 and coupled through C1745 to a resistive network consisting of R1721, R1722, R1724, and R1757. Crystal diode CR1703 rectifies this signal and a positive dc voltage is applied through R1721 and R1724 to V4802. Zener diode CR1710 conducts in an inverse direction when the applied voltage exceeds a predetermined value, serves as a voltage regulator, and conducts (from anode to cathode) when the dc voltage between R1724 and ground exceeds a predetermined value. This action limits the value of dc output voltage from this stage.

c. Capacitor C1719 filters the dc voltage rectified by CR1703. When switch S4801 is in the ADJ position, R4810 is placed in parallel with Zener diode CR1710. The positive dc output voltage of this stage is applied to the control grid of relay control discriminator V4802 (par. 82) in the phase lock indicator subchassis.

75. Frequency Discriminator CR1702
(fig. 56)

a. Tuned circuit Z1705 and crystal unit CR1702 are connected as a frequency discriminator that produces a dc output voltage when the applied frequency is above or below 250 kc. The amplitude and polarity of the dc output will be proportional to the amount and direction of frequency error. If the output of the stabilized master oscillator contains a frequency error, the signal applied to the frequency discriminator will be above or below 250 kc. The 250-kc signal was produced by mixing a signal from the stabilized master oscillator with the 350–450-kc signal from the interpolation oscillator. If any interpoulation oscillator error exists, it is also present in the input signal to the frequency discriminator. To compensate for this error, a dc voltage from the phase detector (par. 78) is applied in series with the output of the discriminator. The combined voltage is applied to the smo control amplifier. The dc voltage from the phase detector corrects the dc output of the frequency discriminator to compensate for any error in the interpolation oscillator frequency.

b. The 250-kc input voltage E_3 is applied across the primary of Z1705 and between the junction of two capacitors connected across the secondary winding and ground. Voltages E_1 and E_2 develop across the halves of the secondary winding. These voltages are formed by the loop current that flows through

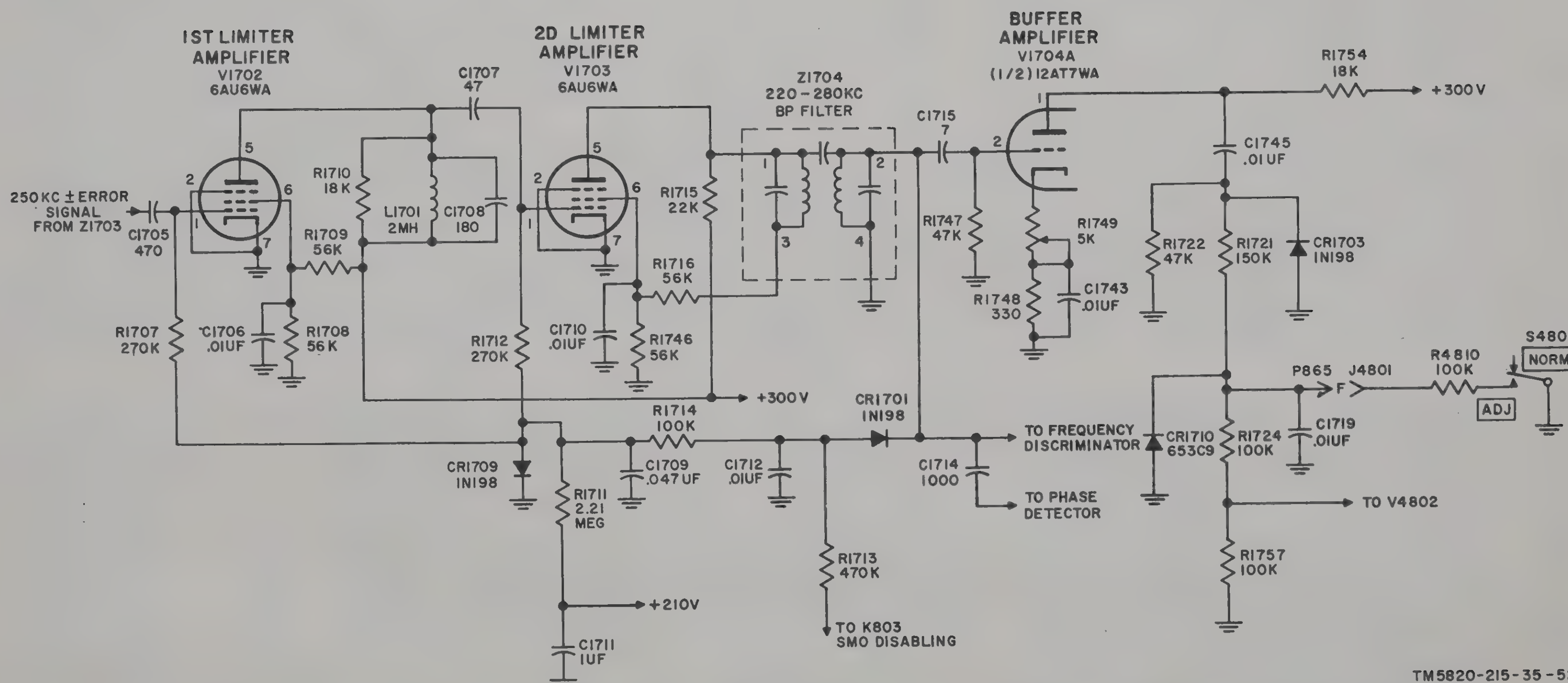


Figure 55. Limiter amplifiers V1702 and V1703 and buffer amplifier V1704A, schematic diagram.

the secondary because of the voltage induced by the primary current. Capacitor C1716 is selected so that the secondary is tuned to exactly 250 kc. When the input is exactly 250 kc, the induced secondary voltage is impressed upon a load that is resonant at this frequency and thus, purely resistive. For the resonant condition, E_1 and E_2 are each at right angles to E_3; E_1 and E_2 are always in opposite directions to each other. The "at resonance" phase relations (A, fig. 56) produce voltages E_{A1} equal in amplitude to E_{A2}. These two voltages are rectified by CR1702A and CR1702B and combined across resistors R1718 and R1719. At resonance, the voltage across R1718 will be equal to but opposite in polarity to the voltage across R1719. The algebraic sum of the two voltages E_4 will be zero, and no correction voltage is developed.

c. When the input signal is above or below the resonant frequency, the induced secondary voltage is across a reactive load. Above resonance, voltage E_{A2} is greater than E_{A1} (B, fig. 56) and the voltage drop across R1719 exceeds the voltage across R1718. A net positive voltage, E4, is developed across C1717 and filtered by R1720 and C1732. This positive voltage is indicative of the frequency error within the 250-kc signal applied to the frequency discriminator.

d. When the input signal is below the resonant frequency, voltage E_{A1} is greater than E_{A2} (C, fig. 56) and the voltage across R1718 exceeds the voltage across R1719. A net negative voltage is developed and applied to the smo control amplifier (par. 79).

76. Reference Limiter V1705

(fig. 57)

a. Reference limiter V1705 limits the 250 kc from second 250-kc amplifier V1206 (par. 71) and applies it to phase detector CR1708 (par. 78) and buffer amplifier V1704B. A gain control network in the grid circuit adjusts the gain of this tube and maintains a relatively constant output amplitude.

b. The 250-kc input is applied to the control grid (pin 1) of V1705. This 250 kc is amplified in V1705 and a portion of the output is fed back to the grid circuit through C1725. Crystal diode CR1706 rectifies this feedback voltage to produce a bias voltage for V1705. A portion of this rectified voltage is coupled through R1730 to meter M803. To reduce the bias voltage to a value required for proper limiter operation, a positive voltage from the band switch is applied to the grid circuit. This voltage is also applied to the screen grid through R1732. The voltage from the band switch is +125 volts on bands 1 through 3, 80 volts on band 4, and 40 volts on band 5. These different voltages vary the gain of V1705 so that the reference limiter output will correspond (on all bands) with the amplitude of the signal applied to frequency discriminator CR1702 (par. 75).

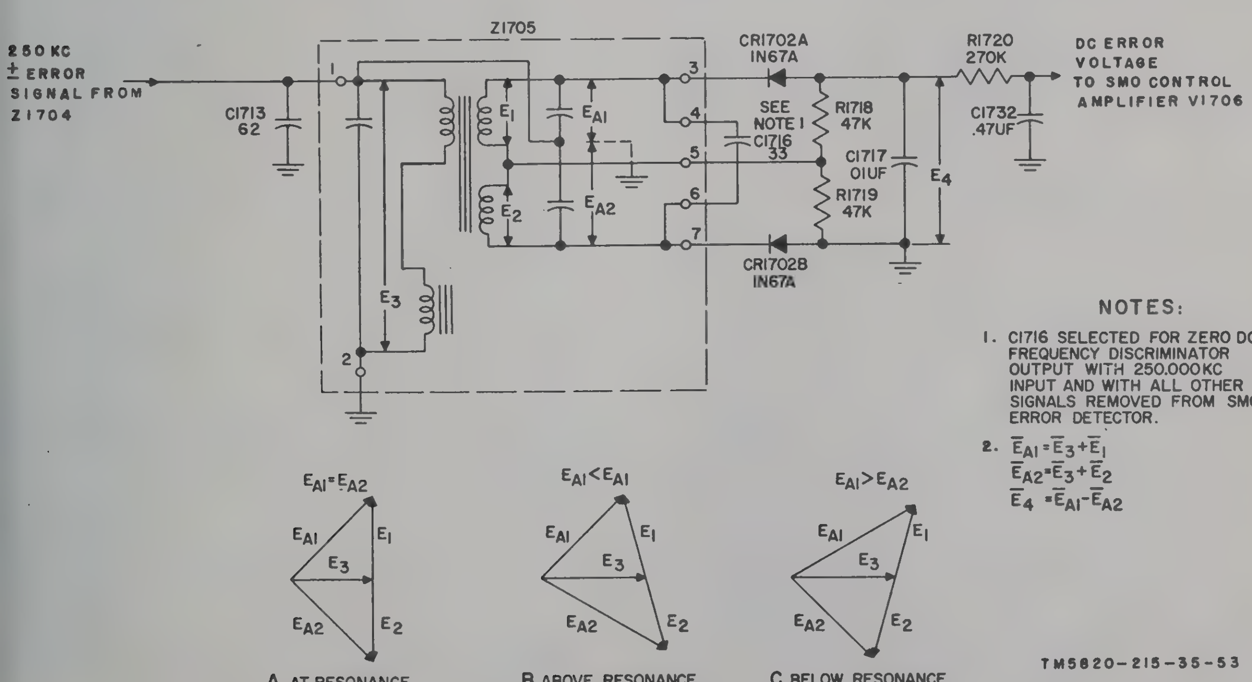


Figure 56. Frequency discriminator, schematic diagram.

c. Capacitor C1723 filters the bias voltage developed in the grid circuit. Capacitor C1724 is a screen grid bypass. The output of this stage is developed across the primary of Z1706 and applied to the phase detector. The output of this stage is also coupled through C1727 and applied to buffer amplifier V1704B. Plate decoupling for the stage is provided by R1733 and C1726.

77. Buffer Amplifier V1704B and CR1707 (fig. 57)

a. Buffer amplifier V1704B isolates relay control discriminator V4802 (par. 82) from reference limiter V1705. The 250-kc input is coupled through C1727 and developed across grid resistor R1752. Tube V1704B amplifies the signal and couples its output through C1746 to half-wave rectifier CR1707. Resistor R1753 is the plate load resistor, and resistor R1755, with C1747, makes up the plate decoupling network. Cathode bias is furnished by R1750, R1751, and C1744. Resistor R1750 is adjustable and provides a means of varying the gain of this stage.

b. The output of the buffer is developed across R1734 in parallel with crystal diode CR1707. When relay K1701 is energized, CR1707 rectifies the output of V1704B and a positive voltage is applied to V4802 through filter resistor R1735. During the smo tuning cycle, the disabling mechanism energizes K803. Contacts on relay K803 ground the relay coil of K1701, disabling the relay and removing the ground return for CR1707 and thereby opening the rectifier circuit. Resistor R1727 is a current limiting resistor in the +300-volt return for the coil of K1701.

78. Phase Detector CR1708 (fig. 58)

a. Third circuit Z1706 and crystal diode CR1708 are connected in a phase detector network that compares two input frequencies. One of the inputs is 250 kc from V1703 that contains both the interpolation oscillator error and the smo error. The other input is a reference signal coupled through reference limiter V1705 from the 0.5-kc spectrum detent subchassis. When the 0.5 KC LOCK switch is set to ON, the 250-kc reference signal contains exactly the same interpolation error that will be in the 250 kc from V1703. The two signals are applied to the phase detector so that the effect of the interpolation error is canceled out completely and only the smo error (if any) is present in the output of the phase detector. When the 0.5 KC LOCK swith is set to OFF, the entire 0.5-kc spectrum detent section is disabled and 250 kc from V1703 is compared with 250 kc that is obtained from the frequency standard compartment. For these applied frequencies, an error in the interpolation oscillator is present in the output of the phase detector and is transferred to the smo unit. This action effectively *overcorrects* the smo for any frequency error within the interpolation oscillator, and the output signal of the modulator-oscillator group is off-frequency by the amount of interpolation oscillator error. The overall error is reduced by the action of the feedback loop in the smo error detector, but the modulator-oscillator output frequency will not be as stable as it is with the 0.5 KC LOCK switch set on ON.

b. With the 0.5 KC LOCK in the ON position, the 250-kc reference signal (from the 0.5-kc spectrum detent) is applied across the primary of Z1706. The 250-kc signal from V1703 is fed to the center tap of the secondary of Z1706. If the only error in the two signals is the interpolation oscillator error the output balances out as shown in A, figure 58. Voltages E_{R1} and E_{R2} across the secondary winding result from the voltage induced by the primary current that is produced by E_R. When E_S contains the same error as E_R (as is the condition when only the interpolation error is present), the phase relationship in the secondary winding is such that voltage E_{A1} (vector sum of E_{R1} and E_S) is equal to E_{A2} (vector sum of E_{R2} and E_S). The two rectifiers conduct equally and the output across R1736 and R1737 balances out. No correction voltage is developed under these conditions.

c. When the 0.5 KC LOCK is set to OFF, the 250-kc signal ($\dot{E}_S$) from V1703 is compared with a 250-kc signal from the frequency standard. If an interpolation error exists, voltages E_{A1} and E_{A2} are not equal and an error voltage is available at the output of the phase detector. The vector diagrams in B and C, figure 58, show the voltage directions in the phase detector when E_S leads E_R and when E_S lags E_R. This lead or lag between the two signals can be the result of the interpolation error or the smo error, or both. The output of this stage, in series with the output of the frequency discriminator (par. 75), is applied to smo control amplifier V1706 (par. 79). The effect of an interpolation error present in the output of the phase detector is to *overcorrect* the stabilized master oscillator and reduce the frequency stability of the unit.

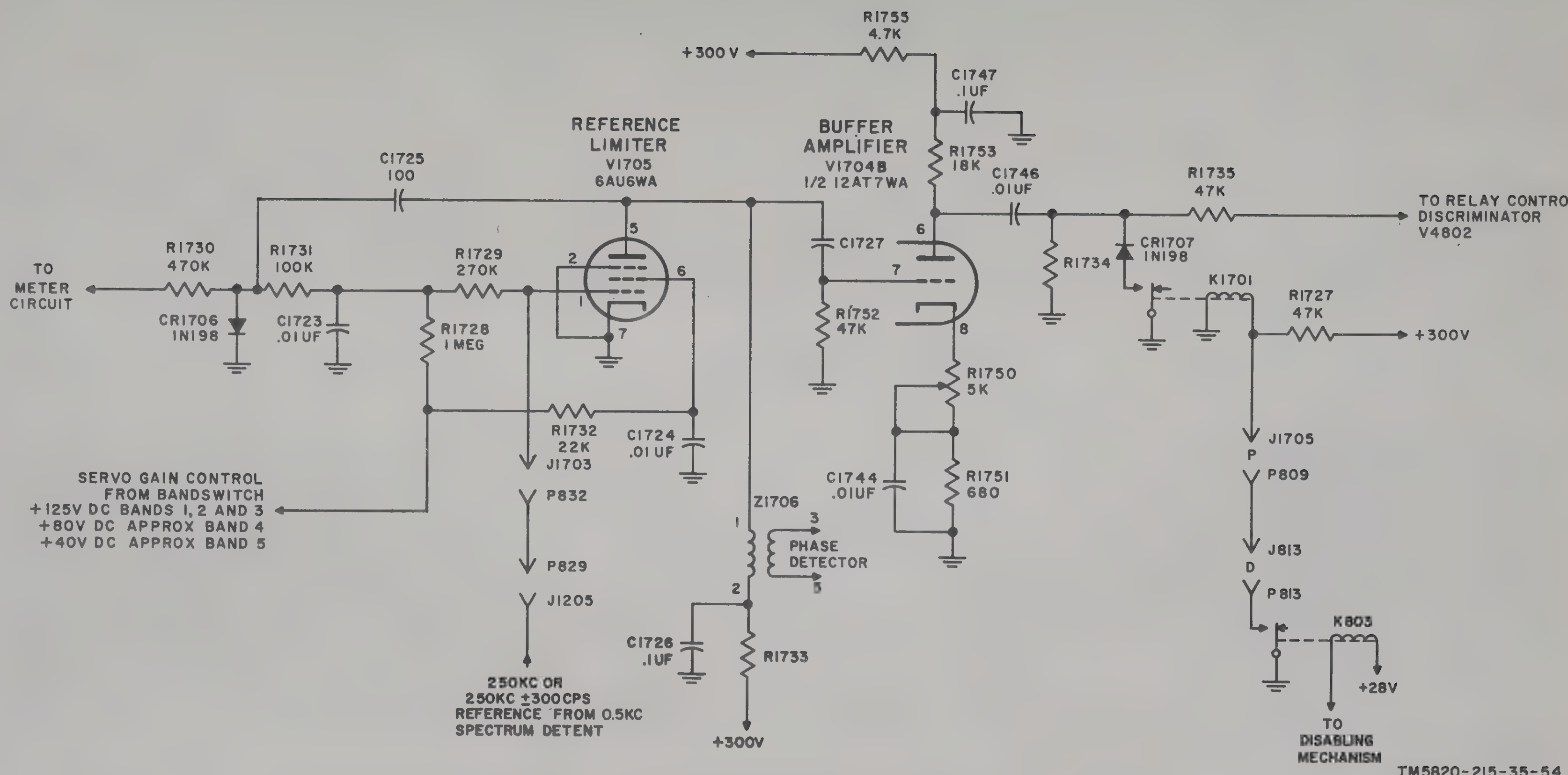


Figure 57. Reference limiter V1705 and buffer amplifier V1704B, schematic diagram.

d. The detector output at the junction of R1736 and R1738 contains an ac component when voltages E_S and E_R are not at the same frequency. This ac voltage is coupled through filter network C1742 and L1703 and applied to V4801 (par. 81). The output of the phase detector is added in series with the dc error voltage from the frequency discriminator (par. 75) and applied to the grid of smo control amplifier V1706. Resistors R1738 and R1739, inductor L1702, and capacitors C1731, C1733, C1734, and C1735 are part of the phase detector output filter circuit. Resistors R1736 and R1737, together with C1729 and C1730, serve as the load for crystals CR1708A and CR1708B. Resistor R1733 and capacitor C1726 are a plate decoupling network for V1705 (fig. 57).

79. Smo Control Amplifier V1706
(fig. 59)

a. Smo control amplifier V1706 receives the combined outputs of the frequency discriminator (par.

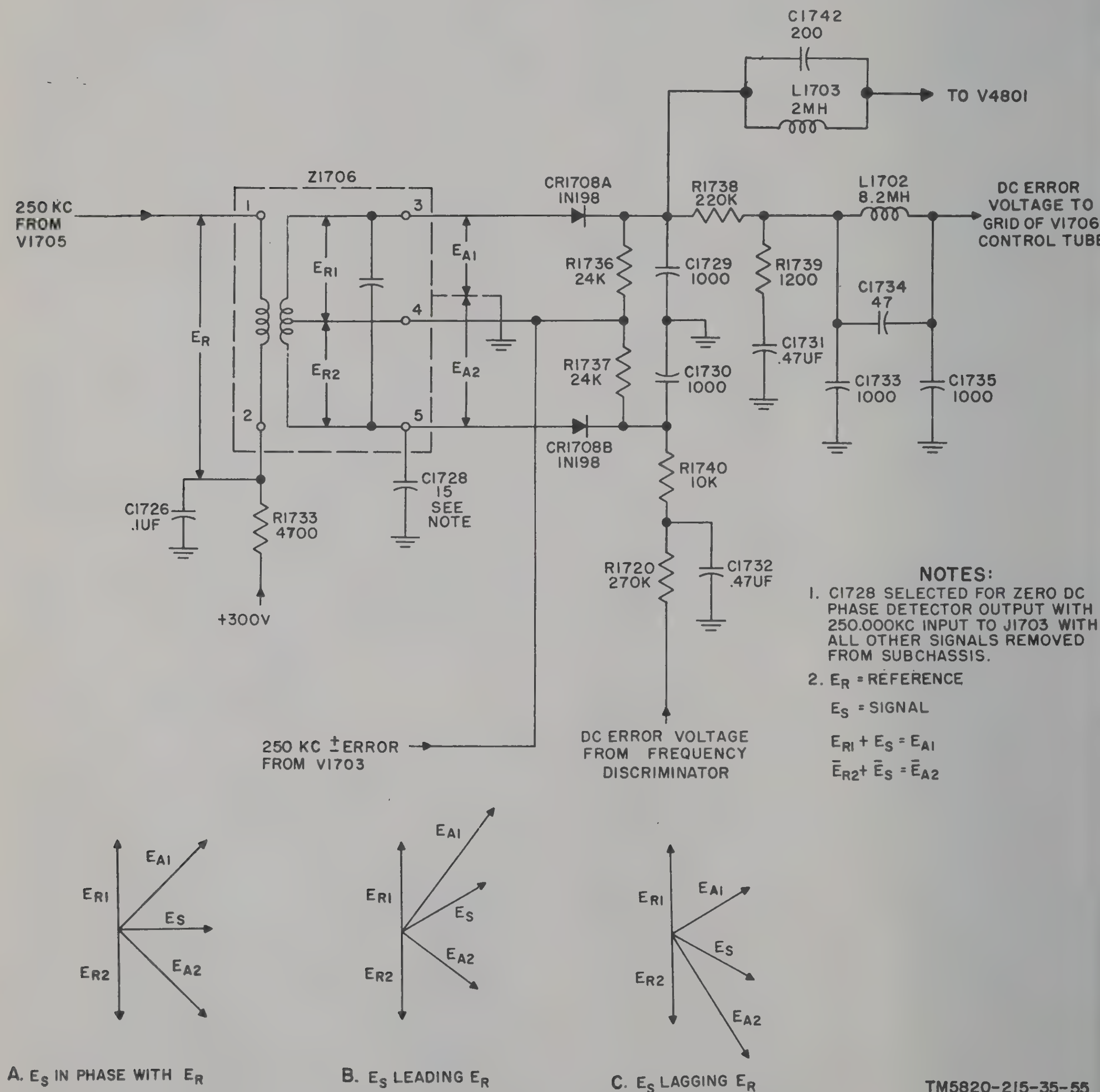


Figure 58. Phase detector CR1708, schematic diagram.

75) and the phase detector (par. 78) and produces an output current that varies the inductance of winding 4–5 of Z1101 the smo circuit (par. 54). This action corrects the frequency of the stabilized master oscillator.

b. The input to V1706 is grounded by relay K1701, which is deenergized while the automatic tuning system is cyling. When K1701 is energized, a dc voltage, proportional to the frequency error within the system, is applied to the control grid of V1706. The dc voltage controls the V1706 plate current through winding 4–5 of Z1101. This winding is an auxiliary winding on coil L1101 in the stabilized master oscillator tuned circuit (par. 54). Current changes through this winding vary the inductance of L1101 and the frequency of the smo is corrected. Cathode bias for the stage is developed across R1741 and adjustable resistor R1742. A portion of the cathode voltage is coupled through R1745 to the meter circuit. The ac component in the cathode voltage is bypassed by C1737. Variable resistor R1742 is adjusted during alignment procedures. Capacitor C1736 and resistor R1744 form a screen grid decoupling network. Test point TP1706 provides access for dc error voltage measurement.

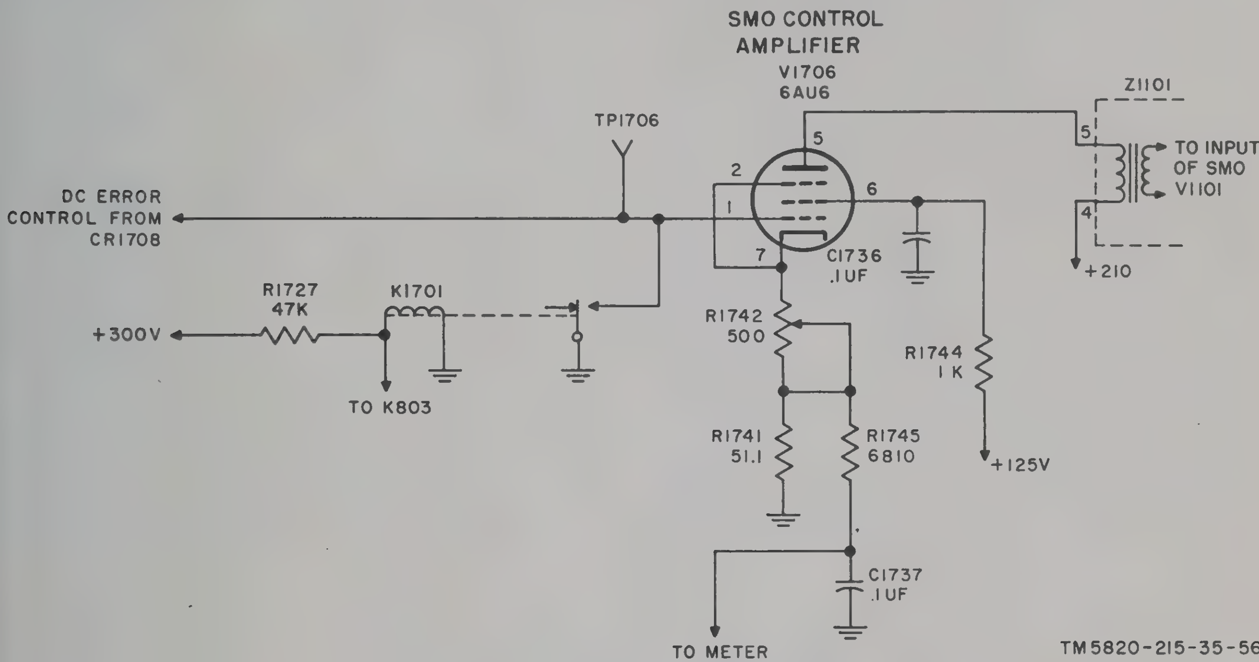


Figure 59. Smo control amplifier V1706, schematic diagram.

Section IV. PHASE LOCK INDICATOR

80. General
(fig. 60)

The phase lock indicator subchassis controls a relay that prevents any output from the exciter-monitor compartment until the stabilized master oscillator is tuned correctly. The phase lock indicator also controls the application of power to the STABILIZED lamp and closes the power amplifier (part of Radio Frequency Amplifier AM–1154A/G) tuneup signal line.

81. Control Amplifier V4801
(fig. 60)

a. Control amplifier V4801 amplifies any ac component (signifying that a frequency error exists) that may be present in the output of the phase detector. The ac component is applied through C4801, developed across the grid impedance of C4802 and R4801, amplified by V4801, and applied across plate load R4803. The V4801 output is coupled through C4805 to the junction of two crystal diodes in the next stage.

b. Plate decoupling is provided by R4805 and C4803. Proper phasing of the input ac error voltage is furnished by R4802 and C4802. Cathode bias is supplied by R4806. Resistor R4804 and capacitor C4804 form a screen grid decoupling network. Test point TP4801 permits access for cathode voltage measurement.

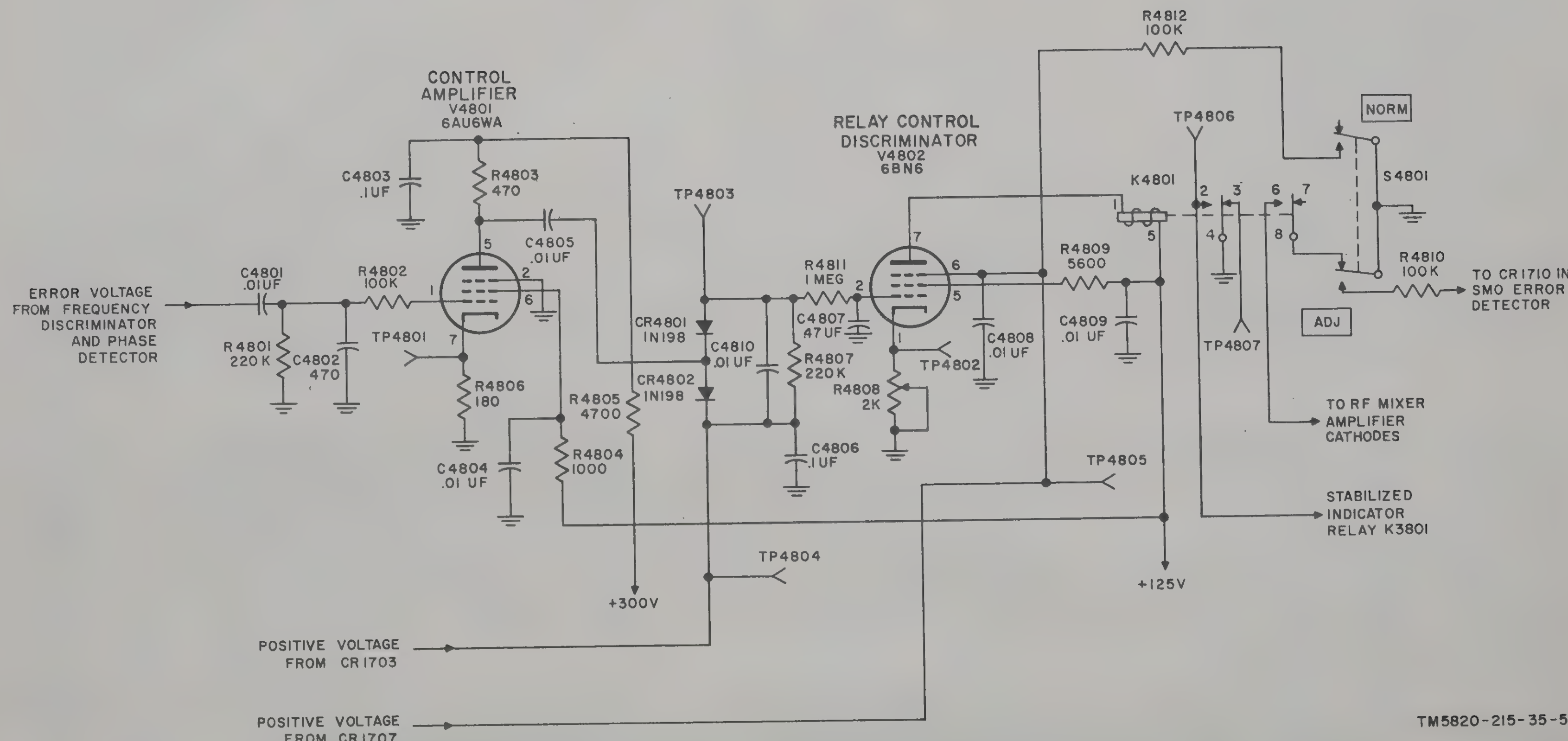


Figure 60. Phase lock indicator subchassis, schematic diagram.

82. Relay Control Discriminator V4802
(fig. 60)

a. The relay control discriminator circuit uses a gated beam-type tube (6BN6) that conducts only if a combination of correct voltages is applied to the tube. The tube is connected so that in addition to the positive potentials that are applied to the plate and accelerator grid (pin 5), a positive voltage to the limiter grid (pin 2) and a positive voltage to the quadrature grid (pin 6) are required before the tube will conduct. If either one of these positive voltages to the limiter grid or quadrature grid drops to zero or becomes negative, the tube is cut off and the relay in its plate circuit is deenergized.

b. When an ac error voltage is applied from V4801 (indicating a frequency error in the system) to the junction of CR4801 and CR4802, the diodes conduct, feeding a negative voltage to the control grid of V4802. This voltage is developed across R4807 and C4810 in series with a positive voltage from CR1703. The combined voltage cuts off V4802, and relay K4801 is deenergized. Contacts 6 and 8 open and the ground return for the mixer-amplifier cathodes is removed, disabling the exciter-monitor output. Contacts 2 and 4 open, relay K3801 is deenergized, the STABILIZED lamp is extinguished, and normally open tuneup signal line to the power amplifier (part of Radio Transmitting Set AN/FRT–51) is grounded.

c. When the phase detector output contains no ac component, no error voltage is applied to CR4801 and CR4802. A positive dc output from CR1703 (par. 74) is applied to the limiter grid (pin 2), and a positive voltage from CR1707 (par. 77) is applied to the quadrature grid (pin 6). Tube V4802 conducts, energizing relay K4801 which closes contacts 2–4 and 6–8. During the smo tuning cycle, the positive voltage to pin 6 disappears and V4802 is cutoff.

d. Resistor R4811 and capacitor C4807 form a long time constant network that prevents transient changes in the phase detector output, caused by normal frequency correction, from cutting off V4802 and thus deenergizing K4801. The cathode bias (which determines at which point relay K4801 energizes) is adjusted during alignment by varying R4808. Capacitor C4808 bypasses the quadrature grid and R4809 is the accelerator grid voltage-dropping resistor. Capacitor C4809 is a filter in the +125-volt line. Switch S4801 is normally set to NORM. When S4801 is in the ADJ position, resistor R4808 is adjusted for correct relay current. In the ADJ position, resistor R4810 is placed in parallel with CR1710 (par. 74) and resistor R4812 is paralleled with CR1707 (par. 77). Test points TD8402, TP4803, TP4804, TP4805, TP4806, and TP4807 provide access for grid, cathode, and plate voltage measurements.

Section V. MONITOR CHASSIS

83. General
(fig. 5)

The monitor is composed of seven stages of mixers, amplifiers, and a demodulator. It samples the signal at a number of points in the modulator-oscillator (including a sample of the power amplifier output) and provides an indication of sampled signal level and an audio output if audio modulation is present. MONITOR INPUT switch S1401 permits application of a sample signal from any one of five points described in the block diagram discussion (par. 84). The selected signal is applied to first mixer-amplifier V1401 which functions as an amplifier for either a 300-kc, a band 1, or a band 2 input signal, and as a mixer that heterodynes band 3, 4, or 5 input signals with frequencies from the smo multipliers. The latter function produces frequencies in the 2- to 4-mc range. The output signal of V1401 is coupled through a low-pass filter (4.5 mc cutoff) to second mixer-amplifier V1402. Tube V1402 acts as an amplifier for a 300-kc input signal only. On bands 1 and 2, the input signal to V1402 is heterodyned with a frequency in the 2- to 4-mc range, which is applied directly from the output of the stabilized master oscillator. On bands 3, 4, and 5, the smo multipliers provide the frequency that is mixed with the input signal. The output of V1402 is fixed at 300 kc for all input frequencies. The 300-kc signal is coupled to first 300-kc amplifier V1403. After amplification by V1403, the signal is further amplified by two 300-kc amplifier stages (second 300-kc amplifier V1404 and third 300-kc amplifier V1406A). The output of V1406A is coupled to diode rectifier CR1401. The amplitude of the rectified

current provides an indication of the monitor input signal level. This pulsating dc current is applied through a filtering network to front-panel meter M801, which furnishes a direct reading of monitor input signal levels in a relative range from 0 to 10 units. The 300-kc signal at the output of the first 300-kc amplifier is also applied to demodulator V1405. The 300-kc signal from the first 300-kc amplifier is mixed in V1405 with a 300-kc signal from the frequency standard to produce the original modulating frequencies. The audio signal is amplified in audio amplifier V1406B and fed to the exciter-monitor junction box for audio output monitoring.

84. Monitor Input Circuits

(fig. 61)

The input circuits to the monitor are contained in a separate monitor control box. The circuits consist of MONITOR INPUT switch S1401, MONITOR LEVEL control R1437, and attenuating and matching resistive networks through which the five input signals are individually channeled to S1401. The selected voltage sampling appears at contact 6 of S1401 and is applied across R1437. The variable arm of R1437 passes a portion of the signal voltage applied to the control to the first mixer-amplifier in the monitor chassis.

a. EXCITER INPUT. A modulated 300-kc signal (ssb or tsb) is supplied from the output of the alc amplifier in the tsb modulator compartment of the modulator-oscillator to the monitor control box. The sample signal then passes through closed contacts 10 and 6 of S1401 and develops a voltage across MONITOR LEVEL control R1437, a portion of which is applied to the first amplifier mixer.

b. EXCITER OUTPUT. A sample of the exciter output signal is taken from the stator terminal of the RF switching element, S4405, in the band switching section of the exciter-monitor. The signal is fed through resistor R4405 in the band switching section to resistor R1445 in the monitor control box. The combination of R4405 and R1445 forms a voltage divider which furnishes the required maximum signal level to the monitor input and functions as a proper match for the source of the exciter output signal. The sample signal is applied across MONITOR LEVEL control R1437 through contacts 11 and 6 of S1401.

c. PA SAMPLING. A small portion of the transmitter power amplifier output signal is applied through the main junction box in the modulator-oscillator to the monitor control box. The pa signal sample then passes through an attenuating and matching pad that consists of resistors R1446, R1442, R1441, and R1439. The signal at the pad output is fed through contacts 12 and 6 of S1401 to MONITOR LEVEL control R1437.

d. EXTERNAL. A signal cabled to EXTERNAL PICKUP jack J1411 on the exciter-monitor front panel appears at the input to an attenuating and matching pad consisting of resistors R1447, R1444, R1443, and R1440. The pad provides a proper match for a 52-ohm RF coaxial cable. The attenuated signal at the pad output is fed through contacts 1 and 6 of S1401 to MONITOR LEVEL control R1437.

e. TEST. A 300-kc signal from the 1-mc to 100-kc divider in the frequency standard is coupled through R1448 in the monitor chassis to the monitor control box. The voltage developed across terminating resistor R1438 is applied through contacts 2 and 6 of S1401 to MONITOR LEVEL control R1437. The amount of 300-kc voltage across R1437 is a result of the voltage division between R1448 in series with parallel-connected R1438 and R1437.

85. First Mixer-Amplifier V1401

(fig. 62)

The signal voltage at the variable arm of MONITOR LEVEL control R1437 passes into the monitor chassis and is applied to the RF injection grid, pin 1, of first mixer-amplifier V1401. Tube V1401 is a pentagrid tube that functions as an amplifier when the input signal is 300 kc on a band 1 or band 2 frequency, and operates as a mixer on inputs at bands 3, 4, or 5 frequencies. The result of the mixing action produces frequencies in the 2- to 4-mc range, which are coupled through a low-pass filter (4.5-mc cutoff) to the second mixer-amplifier.

a. When V1401 operates as a mixer, two signals at the inputs to the tube are heterodyned by the variation in tube gain caused by the application of the higher amplitude signal. This is accomplished through control of an electron stream (plate current) that is common to both input circuits. The RF from the MONITOR LEVEL control R1437 appears at pin 1 of V1401. The other mixing frequency is furnished by the smo multipliers, which provide the mixing frequencies for bands 3, 4, and 5. The smo multiplier frequency is coupled from the band switch in the smo RF section of the exciter to the

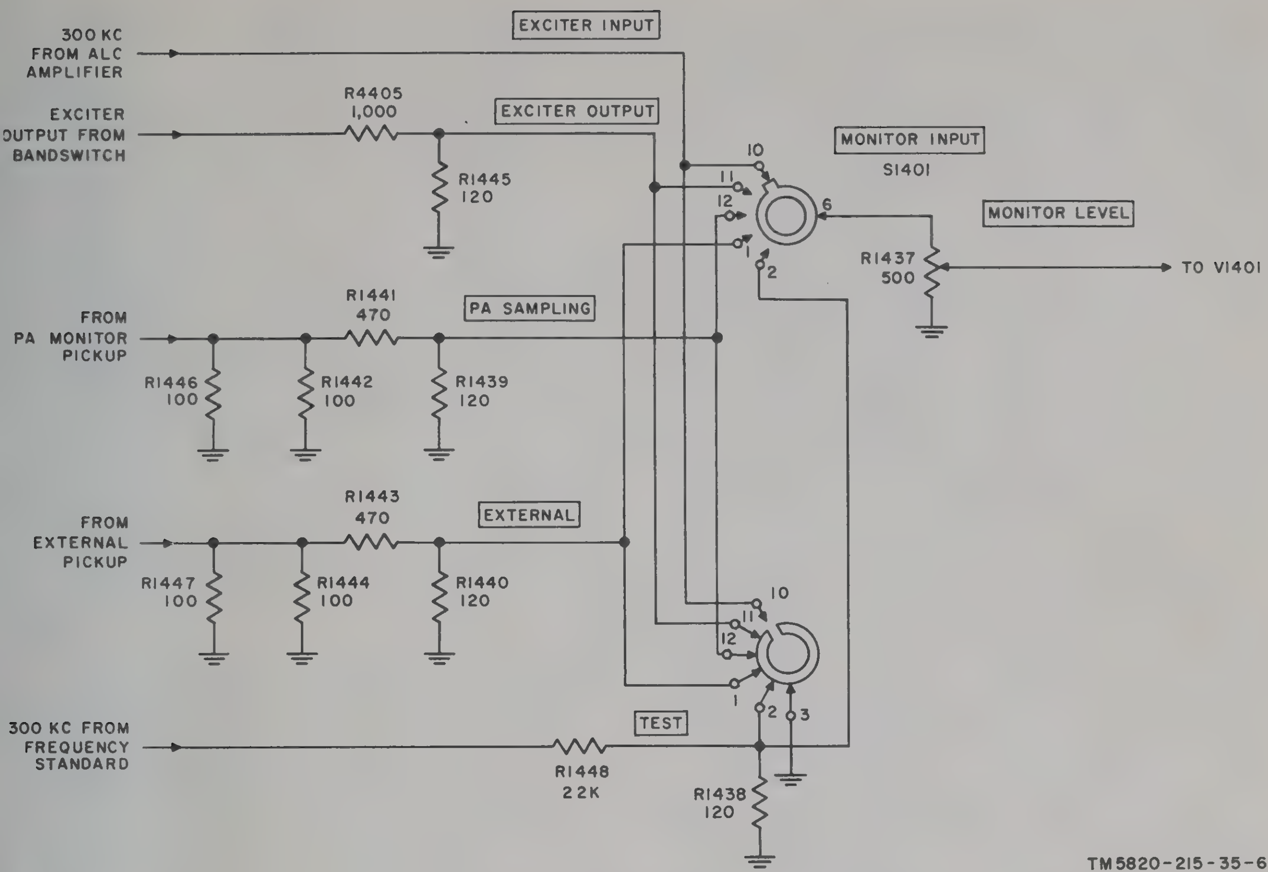


Figure 61. Monitor input circuits, schematic diagram.

monitor chassis and develops a voltage across R1402. This voltage is impressed at pin 7 of V1401 through parasitic oscillation suppressor resistor R1401.

b. The resultant frequencies of the mixing of the two input signals appear across R1406, the plate load resistor of V1401. Capacitor C1404 couples the V1401 output frequencies to low-pass filter Z1401. Filter Z1401 has a frequency response characteristic which cuts off all frequencies above 4.5 mc. Because the input frequencies to V1401 (operated as a mixer) are either very close to or above the filter cutoff frequency, only the difference frequencies (2 to 4 mc) in the V1401 output are passed to the following stage.

c. Resistor R1404 in the cathode circuit provides proper operating bias for V1401 as a mixer or as an amplifier (*d* below). Capacitor C1401 bypasses R1404 for RF. Resistor R1405 is a screen voltage-dropping resistor that is bypassed for RF by capacitor C1402. Resistor R1407 and capacitor C1403 form a plate and screen circuit decoupling network that prevents V1401 output frequencies from interacting with other stages in the monitor chassis. Test point TP1401 permits access for cathode voltage measurement.

d. When V1401 functions as an amplifier (300 kc on band 1 or 2 input), the input to pin 7 is shorted to ground through the band switch in the smo-RF section of the exciter. The amplified frequencies are passed through low-pass filter Z1401 to the following stage.

86. Second Mixer-Amplifier V1402
(fig. 62)

The signal applied to second mixer-amplifier V1402 from the output of first mixer-amplifier V1401 is either a frequency in the range of 2 to 4 mc or a 300-kc signal (dependent upon the position of the MONITOR INPUT selector switch). When the signal is in the 2- to 4-mc range, V1402 functions as a mixer and heterodynes the frequency from the stabilized master oscillator with the signal from the preceding stage. The smo frequency is always 300 kc removed from the input signal to V1402 when it

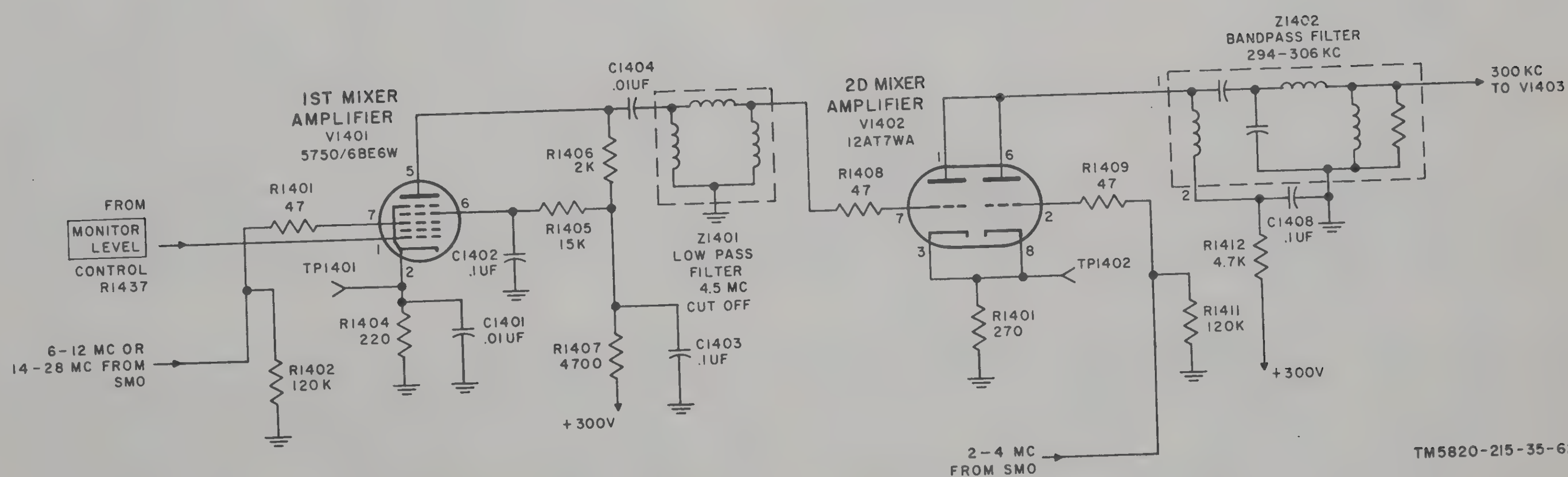


Figure 62. First and second mixer-amplifiers V1401 and V1402, schematic diagram.

operates as a mixer. The difference frequency of 300 kc is selected by a narrow band filter in the V1402 plate circuit and is coupled to the first 300-kc amplifier. When the input signal to V1402 is 300 kc, the mixing frequency from the smo is grounded and the tube performs as an RF amplifier.

a. Tube V1402 operates as a dual-triode mixer for input signals in the 2- to 4-mc range. Plate pins 1 and 6 are joined and cathode pins 3 and 8 are joined; the grids, pins 7 and 2, are independently driven by the mixing signals. The signal from V1401 is applied to grid, pin 7, of V1402 through parasitic oscillation suppressor resistor R1408. The smo frequency voltage developed across resistor R1411 is applied to grid, pin 2, through parasitic suppressor resistor R1409. The larger RF voltage modulates the other by varying the bias developed across common-cathode resistor R1401 and applied to both triodes.

b. The RF voltage at the joined plates of V1402 contains the original mixing frequencies and the sum and difference frequencies. Band-pass filter Z1402 is a narrow band-pass filter that is centered at 300 kc. The filter band pass is sufficient to pass a twin-sideband signal (300 kc, ±6 kc). The 300-kc difference frequency, selected by Z1402, passes through the filter to the grid of the first 300-kc amplifier. Resistor R1412 and capacitor C1408, in the plate circuit of V1402, form a plate circuit decoupling filter.

87. 300-Kc Amplifiers
(fig. 63)

The 300-kc amplifiers are in a cascaded arrangement and amplify the 300-kc output of second mixer-amplifier V1402. The output of third 300-kc amplifier V1406A is coupled to shunt-connected, crystal-diode rectifier CR1401. The rectified signal current is filtered and applied in series with signal level indicating meter M801, to furnish a reading that is proportional to the signal amplitude at the monitor input.

a. The 300-kc output of second mixer-amplifier V1402 is coupled through capacitor C1412 to the control grid of first 300-kc amplifier V1403. The signal voltage develops across grid-return resistor R1413. The V1403 output appears across a tuned-plate load which consists of inductor L1402, capacitor C1416, and tuned-circuit damping resistors R1418 and R1417 in series. A voltage, which is about half the voltage across the tuned circuit, is taken from the junction of the resistors and applied to demodulator V1405 (par. 88). The full output of V1403 is coupled through dc blocking capacitor C1432 to second 300-kc amplifier V1404. Cathode resistor R1414, bypassed for RF by capacitor C1415, provides self-bias for the V1403 input circuit. Test point TP1403 permits measurement of cathode voltage. Resistor R1415 is a screen voltage-dropping resistor that is bypassed for RF by capacitor C1414. Resistor R1416 and capacitor C1417 form a plate and screen circuit decoupling network.

b. The 300-kc signal coupled to the control grid of second 300-kc amplifier V1404 develops across grid-return resistor R1432. The output voltage of V1404 is formed across plate load resistor R1435. The low ohmic value of R1435 permits proper operation of V1404 as a resistance-capacitance-coupled RF amplifier. Dc blocking capacitor C1435 couples the V1404 output to the grid of third 300-kc amplifier V1406A. Unbypassed cathode resistor R1433 furnishes self-bias for the V1404 input circuit and provides degeneration to minimize harmonic production under various levels of input signal. Test point TP1404 facilitates cathode voltage measurement. Resistor R1434 is a screen voltage-dropping resistor that is bypassed for RF by capacitor C1433. Resistor R1436 and capacitor C1434 form a screen and plate circuit decoupling network.

c. The 300-kc signal coupled to the grid of third 300-kc amplifier V1406A develops across grid-return resistor R1427. The V1406A output voltage develops across plate load resistor R1428 and is coupled by dc blocking capacitor C1429 to diode rectifier CR1401 and the signal level metering circuit. Cathode resistor R1426 supplies self-bias to the stage and is bypassed for RF by capacitor C1428. Test point TP1407 permits measurement of cathode voltage. Resistor R1429 and capacitor C1430 decouple the V1406A plate circuit from the preceding stages. Inductor L1403 and capacitor C1418 prevent RF in the cascaded amplifier output circuits from entering the +300-volt dc line.

d. Diode rectifier CR1401 functions as a shunt-type rectifier which conducts heavily for half of each applied RF cycle and shorts it to ground. The remaining half-cycle represents a pulsating dc voltage which causes a current through the network that parallels CR1401. At the base of this network is signal level indicating meter M801. Resistor R1430 and capacitor C1431 form an rc filter combination that removes the RF pulsation in the

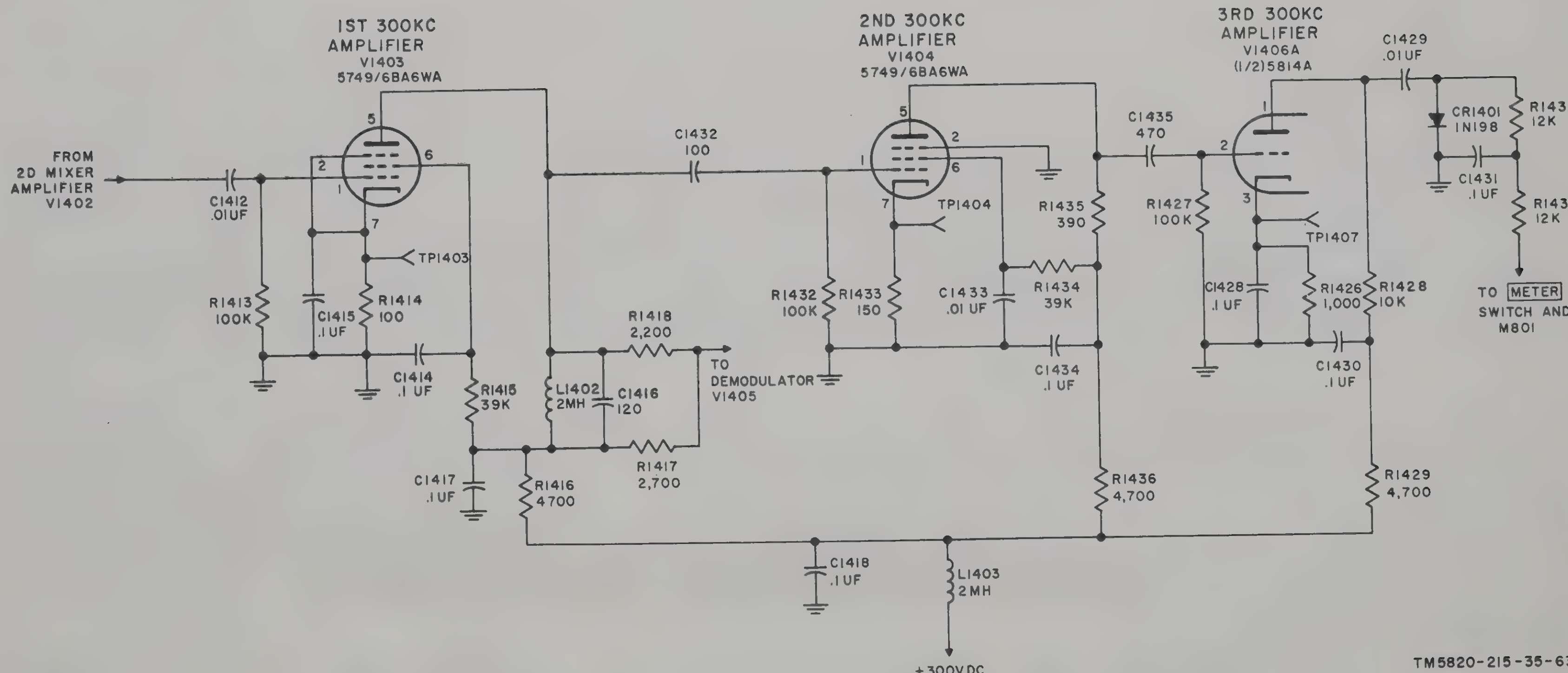


Figure 63. 300-kc amplifiers, schematic diagram.

rectified meter current. Resistor R1431 limits this current to a value within the range of the meter. The filtered dc passes through the closed contacts of the METER SWITCH to meter M801.

88. Demodulator and Audio Amplifier
(fig. 64)

Demodulator V1405 is a product demodulator circuit which mixes the 300-kc signal from first 300-kc amplifier V1403 (par. 87) with a 300-kc signal from the 1-mc to 100-kc divider in the frequency standard. The demodulator output contains the modulating signal frequencies plus distortion components introduced in the amplifying and mixing stages that precede the particular test point selected by the MONITOR INPUT switch (par. 84). The V1405 output is filtered of RF components and is coupled to audio amplifier V1406B. The audio output voltage of V1406B is fed to a monitor audio output terminal on plug P802 for connection to a headset or to provide information for spectrum analysis to determine the relative amplitudes of undesired distortion products.

a. A portion of the output of first 300-kc amplifier V1403 (par. 87) is coupled through capacitor C1419 to the grid, pin 2, of one triode of demodulator V1405. The 300-kc voltage develops across grid-return resistor R1419. A 300-kc signal from the 1-mc to 100-kc divider in the frequency standard is coupled to the grid, pin 7, of the other triode through capacitor C1420 and develops across resistor R1421. The two input signals are mixed by the action of cathode resistor R1420, which is common to both triodes. The modulating audio signal frequencies, distortion components, and original and sum radiofrequencies appear at the plate, pin 6, of the triode driven from the frequency standard. The plate, pin 1, of the other triode is placed at ac ground potential by capacitor C1425. All RF components in the ungrounded triode plate current are removed by a filter consisting of inductor L1404 and capacitors C1422, C1421, C1423. The remaining audiofrequency (including distortion) voltages develop across plate load resistor R1422 and are coupled through dc blocking capacitor C1424 to the grid of audio amplifier V1406B. Resistor R1423 is a plate voltage-dropping resistor for the signal-driven triode of V1405. Test point TP1405 permits access to the joined demodulator cathodes for either a voltage or a waveform measurement.

b. The audio voltage is coupled from V1405 to the grid, pin 7, of audio amplifier V1406B and develops across grid-return resistor R1424. The primary of output transformer T1401 is the plate load for V1406B and develops the output voltage which is inductively coupled to the transformer secondary. The ungrounded side of the secondary winding is connected to the monitor audio output terminal of plug P802. Capacitor C1438 prevents ringing in transformer T1401 during sharp-peaked output waveforms. Cathode resistor R1425, bypassed for audiofrequencies by parallel-connected capacitors C1426 and C1427, provides self-bias for the stage. Test point TP1406 allows access for cathode voltage measurement.

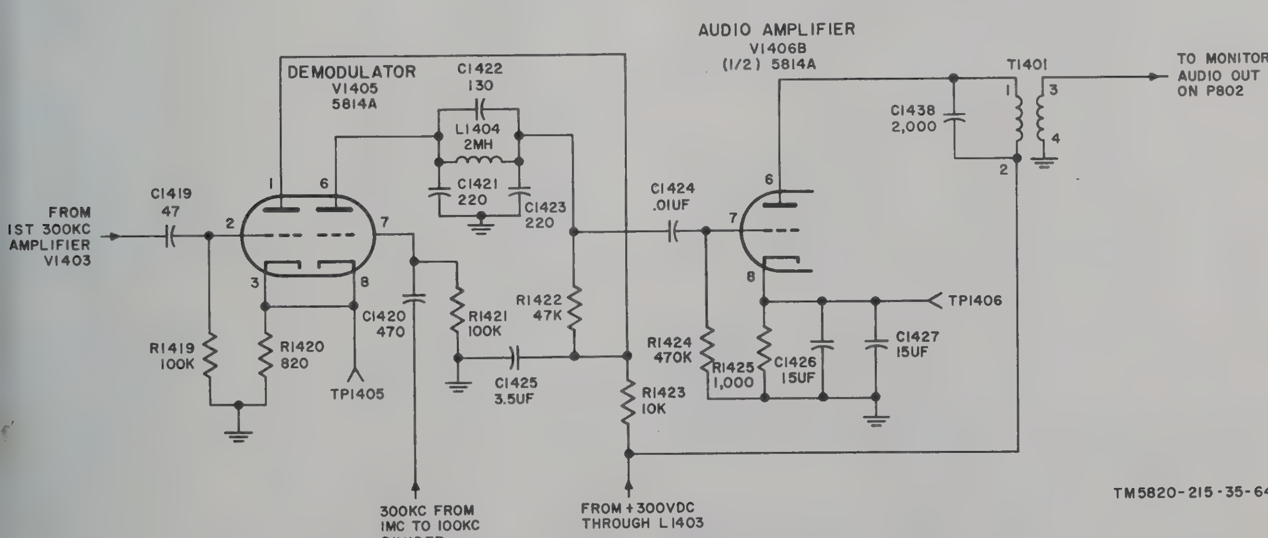


Figure 64. Demodulator and audio amplifier, schematic diagram.

Section VI. EXCITER-MONITOR FILAMENT DISTRIBUTION

89. Filament Power Input Circuit
(fig. 65)

a. When FILAMENT ON switch S3604 is pressed, 115 volts ac is applied to the coil of filament power relay K2301. The line voltage is directly applied to the heaters in the interpolation oscillator and stabilized master oscillators HR1001 and HR1101. Heater switches S1001 and S1101 are thermostat-type switches that are normally closed. Capacitors C1008 and C1111 are connected across the heater switches and prevent arcing.

b. When K2301 is energized, contacts 4 and 5 close and 115 volts ac is applied to the primary of power transformer T801. Bypass capacitors C814 and C815 are placed between each side of the line and ground to filter any noise in the input ac line.

90. Filament Distribution
(fig. 65)

The secondary of T801 is a center-tapped, 12.6-volt winding. All 6.3-volt tubes are connected between terminal 3 or terminal 6 of the secondary and ground. Tubes that require 12.6 volts are connected across the entire secondary winding. Individual filament sections in the various subchassis of the exciter-monitor compartment are bypassed to ground by capacitors connected to each side of the filament lines within the subchassis. This prevents undesired coupling between the various subchassis through the filament distribution network.

Section VII. AUTOMATIC TUNING SYSTEM

91. General.
(fig. 66)

The automatic tuning system automatically positions the tuning elements of the exciter-monitor to exact, predetermined positions. These positions are initially determined by the operator, who presets the various desired operating frequencies by positioning the BAND, FREQ-MC, and FREQ-KC controls for each desired channel of operation (par. 28, TM 11–5821–212–10). After the channel frequencies are preset, the selection of a channel will energize the automatic tuning system. The automatic tuning circuits time the tuning cycle so that the following operations are performed when the CHANNEL switch is set to a new channel setting:

a. Automatic tuning motor B801 drives three positioning heads to their home stops (low end of the tuning range). The three positioning heads control the band of operation, the frequency in megacycles, and the frequency in kilocycles.

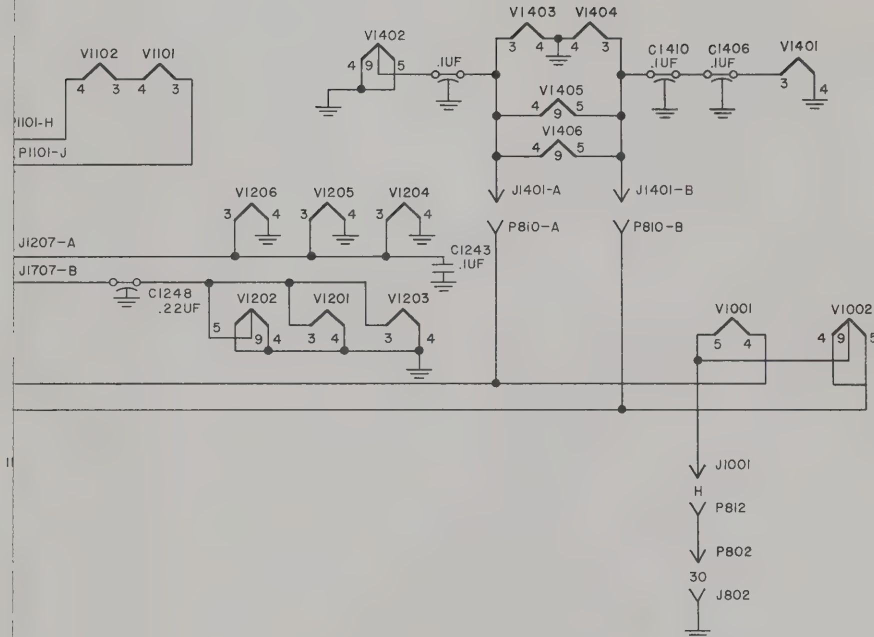
b. After the homing operation, motor B801 continues to run in the same direction while the seeking switch in the control head seeks the one position that corresponds to the selected channel. Locating this position reverses the motor.

c. When motor B801 reverses, the three positioning heads are driven towards the upper end of the tuning range. When a positioning head (band, frequency-mc, or frequency-kc) reaches the preset position corresponding to the frequency selection for this channel setting, a pawl in the positioning head stops the head output shaft.

92. Homing Operation
(fig. 66)

a. The condition of the automatic tuning circuits just after CHANNEL switch S802 has been rotated to the selected channel is shown in A, figure 66. Switch S802 completes the +28-volt ground return path for relays K801 and K802. The ground return path for K801 is from the number 10 terminal of the relay coil, through contacts 6–5 (rear) of the control head seeking switch, and through contacts 5–8 (rear) of S802. The return path for K802 is similar, except that it is first routed through the contacts of the shutoff limit switch. The circuit conditions just as relays K801 and K802 are energized but before the relay contacts have had time to close is shown in A, figure 66.

b. Figure 66B shows all the relay contacts of K801 and K802 in the energized positions. Contacts 2–3 of K802 complete the field winding path of B801 to +28 volts, and contacts 2–3 (right) and contacts 2–3 (left) of K801 complete the B801 armature path from ground to +28 volts. Motor B801 runs and drives the BAND, FREQ-MC, and FREQ-KC positioning heads to their home stops



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Section VI. EXCITER-MONITOR FILAMENT DISTRIBUTION

89. Filament Power Input Circuit
(fig. 65)

a. When FILAMENT ON switch S3604 is pressed, 115 volts ac is applied to the coil of filament power relay K2301. The line voltage is directly applied to the heaters in the interpolation oscillator and stabilized master oscillators HR1001 and HR1101. Heater switches S1001 and S1101 are thermostat-type switches that are normally closed. Capacitors C1008 and C1111 are connected across the heater switches and prevent arcing.

b. When K2301 is energized, contacts 4 and 5 close and 115 volts ac is applied to the primary of power transformer T801. Bypass capacitors C814 and C815 are placed between each side of the line and ground to filter any noise in the input ac line.

90. Filament Distribution
(fig. 65)

The secondary of T801 is a center-tapped, 12.6-volt winding. All 6.3-volt tubes are connected between terminal 3 or terminal 6 of the secondary and ground. Tubes that require 12.6 volts are connected across the entire secondary winding. Individual filament sections in the various subchassis of the exciter-monitor compartment are bypassed to ground by capacitors connected to each side of the filament lines within the subchassis. This prevents undesired coupling between the various subchassis through the filament distribution network.

Section VII. AUTOMATIC TUNING SYSTEM

91. General.
(fig. 66)

The automatic tuning system automatically positions the tuning elements of the exciter-monitor to exact, predetermined positions. These positions are initially determined by the operator, who presets the various desired operating frequencies by positioning the BAND, FREQ-MC, and FREQ-KC controls for each desired channel of operation (par. 28, TM 11–5821–212–10). After the channel frequencies are preset, the selection of a channel will energize the automatic tuning system. The automatic tuning circuits time the tuning cycle so that the following operations are performed when the CHANNEL switch is set to a new channel setting:

a. Automatic tuning motor B801 drives three positioning heads to their home stops (low end of the tuning range). The three positioning heads control the band of operation, the frequency in megacycles, and the frequency in kilocycles.

b. After the homing operation, motor B801 continues to run in the same direction while the seeking switch in the control head seeks the one position that corresponds to the selected channel. Locating this position reverses the motor.

c. When motor B801 reverses, the three positioning heads are driven towards the upper end of the tuning range. When a positioning head (band, frequency-mc, or frequency-kc) reaches the preset position corresponding to the frequency selection for this channel setting, a pawl in the positioning head stops the head output shaft.

92. Homing Operation
(fig. 66)

a. The condition of the automatic tuning circuits just after CHANNEL switch S802 has been rotated to the selected channel is shown in A, figure 66. Switch S802 completes the +28-volt ground return path for relays K801 and K802. The ground return path for K801 is from the number 10 terminal of the relay coil, through contacts 6–5 (rear) of the control head seeking switch, and through contacts 5–8 (rear) of S802. The return path for K802 is similar, except that it is first routed through the contacts of the shutoff limit switch. The circuit conditions just as relays K801 and K802 are energized but before the relay contacts have had time to close is shown in A, figure 66.

b. Figure 66B shows all the relay contacts of K801 and K802 in the energized positions. Contacts 2–3 of K802 complete the field winding path of B801 to +28 volts, and contacts 2–3 (right) and contacts 2–3 (left) of K801 complete the B801 armature path from ground to +28 volts. Motor B801 runs and drives the BAND, FREQ-MC, and FREQ-KC positioning heads to their home stops

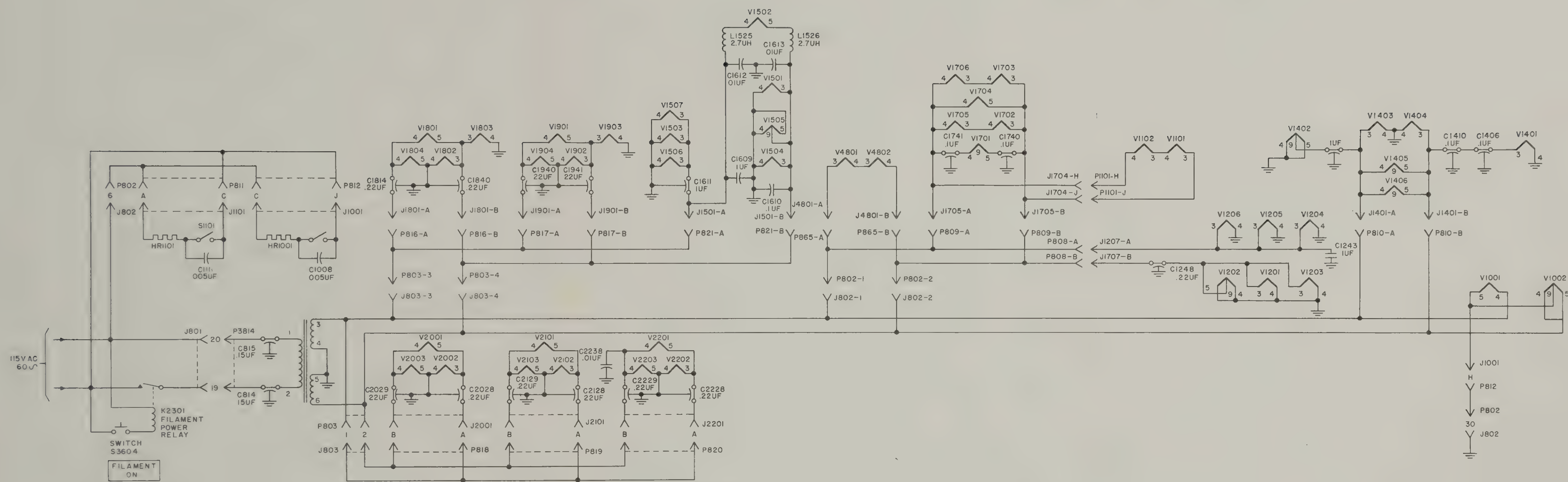

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Figure 65. Power input and filament distribution of exciter-monitor compartment.

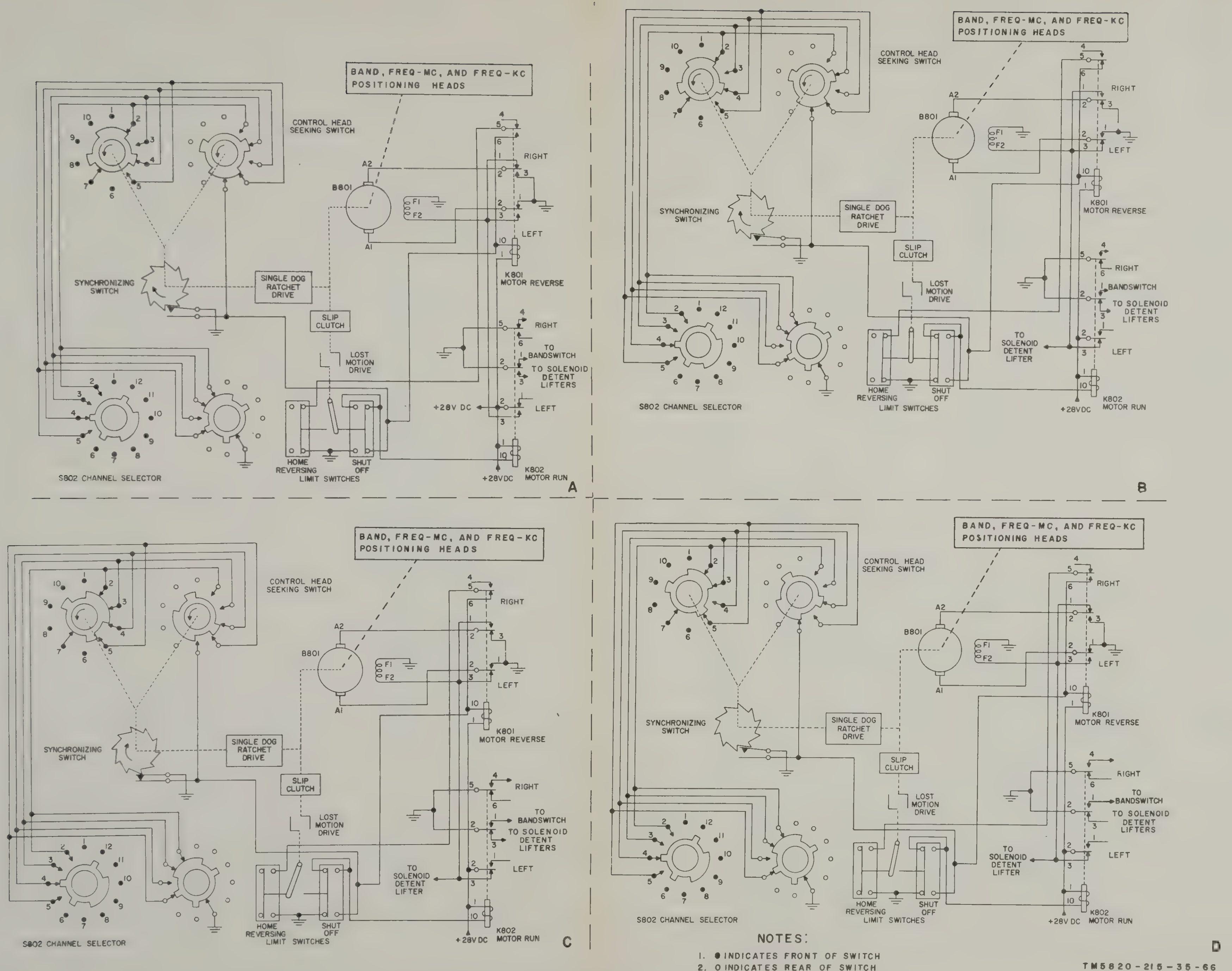

Figure 66. Automatic tuning circuits, simplified schematic diagram.

This action positions all the tuning elements in the exciter-monitor to the low end of the tuning range. A slip clutch and lost motion drive arrangement delays the operation of the home reversing limit switch until all positioning heads have been driven to their home stops. Figure 66B shows the actuating arm of the spring-loaded limit switches in the center position, and the ground return path for K801 (through holding contacts 5–6 of K801) and K802 is through the grounded contacts of the limit switches. When the lost motion drive operates the limit switches (C, fig. 66), the ground return path for K801 must be through the synchronizing switch or the control head seeking switch and S802 because the ground path at the limit switch is open for K801. The ground return for K802 is still completed through the shutoff contacts of the limit switches. This action completes the homing operation.

93. Seeking Operation

(fig. 66)

Figure 66C shows the circuit conditions just at the point where the homing operation has been completed and the seeking operation is ready to start. At this instant, the ground path for motor reverse relay K801 is through the closed contact of the synchronizing switch (driven by a single dog ratchet drive). Figure 66C shows the control head seeking switch just before it contacts the one position that will open the ground return path for K801. Figure 66D shows the control head seeking switch in the position that opens the ground return path for K801. As shown in D, the circuit is opened as soon as the rotor fingers leave the stator contacts of the previous position. The synchronizing switch (also driven by motor B801 and controlled by a single dog ratchet drive) is closed whenever the rotor fingers (of the control head seeking switch) are between stator contacts. This prevents premature deenergization of relay K801. When the ground return path for relay K801 is opened, the relay is deenergized and the relay contacts are released. This action reverses the armature current through B801 because armature current is now routed through left contacts 1–2 and right contacts 1–2 to the +28-volt supply. This action initiates the tuning operation (par. 94).

94. Tuning Operation

(fig. 66)

a. Figure 66D shows the circuit conditions at the start of the tuning operation. Relay K801 has just been deenergized and the direction of rotation of drive motor B801 is reversed. When the motor is reversed, the rotation of the synchronizing switch and the control head seeking switch stops and they remain in the position shown in D. The positioning heads (band, frequency-mc, and frequency-kc) are driven towards the high end of the tuning range.

b. During the presetting of a particular channel frequency, when the BAND, FREQ-MC, and FREQ-KC tuning shafts are tuned, a pawl within a cam drum inside the positioning head is positioned automatically to correspond to the desired frequency setting. As the three positioning heads are driven towards the higher frequency range, the pawl selected by the cam drum in each positioning head is free to fall into a corresponding stop ring slot. As the stop ring slot corresponding to the selected pawl reaches its preset position in each positioning head, the pawl drops into the slot and the positioning head stops. A slip clutch permits the drive gear of motor B801 to continue rotating after the output shaft has been stopped because it is necessary for the motor to run long enough to cover the entire tuning range of the positioning head for each tuning cycle.

c. The lost motion drive times the tuning cycle. When the end of the cycle is reached, the lost motion drive operates the shutoff limit switch (to the position shown in A, fig. 66) and motor run relay K802 is deenergized. This action opens K802 relay contacts and breaks the field and armature +28-volt return. Motor B801 stops, thereby completing the tuning cycle.

CHAPTER 5

THEORY OF POWER SUPPLY AND POWER CONTROL PANELS

Section I. POWER SUPPLY

95. General

The modulator-oscillator power supply provides all the required dc potentials for the compartments within this equipment. A front-panel meter, together with a meter switch, provides a means of checking the individual dc supply voltages. The complete schematic diagram for the power supply is shown in figure 155. The individual supplies are shown in figures 67 through 70 and the theory is covered in paragraphs 96 through 101.

96. Frequency Standard +150- and +300-Volt Supplies

(fig. 67)

a. Rectifier V2301 and voltage regulator V2305 provide the +150-and +300-volt potentials required by the frequency standard compartment. One hundred fifteen volts ac is applied to the primary of T2301. Winding 6–7–8 provides the necessary 5 volts for the filament of V2301. Winding 3–4–5 provides the high-voltage ac to both plates of V2301, which is connected as a full-wave rectifier. A choke input filter consisting of L2301, L2302, R2301, C2301 through C2303, and C2311 filters the rectified output of V2301. The voltage at the junction of L2301 and L2302 is +300 volts dc and is applied directly to the crystal oven in the frequency standard compartment.

b. Series current limiting resistor R2310 and voltage regulator V2305 limit the voltage across the regulator tube to +150 volts. This voltage is applied to the oscillator circuits within the frequency standard compartment. Both the +150- and +300-volt supplies are connected through S2301 to meter M2301 for checking purposes.

97. Power Input Circuit

(fig. 68)

The power input circuit contains the filament and plate power switches and a delay motor that delays the application of voltage to the high-voltage plate transformer. When the FILAMENT ON pushbutton is pressed, 115 volts ac is applied to filament power relay K2301. This action closes contacts 4–5 of K2301 and 115 volts ac is applied across the primaries of T2302, T2305, and the motor that controls delay relay K2303. Transformer T2302 powers the +28-volt rectifier circuit and T2305 powers the —105-volt supply. The time-delay motor closes contacts 5 and 6 of K2303 1 minute after the filament voltage is applied. This action prevents the simultaneous application of filament and plate voltages to gas thyratrons V2302 and V2303 (fig. 69). The PLATE ON switch applies +28 volts to plate power relay K2302 through contacts 5 and 6 of delay relay K2303. When plate

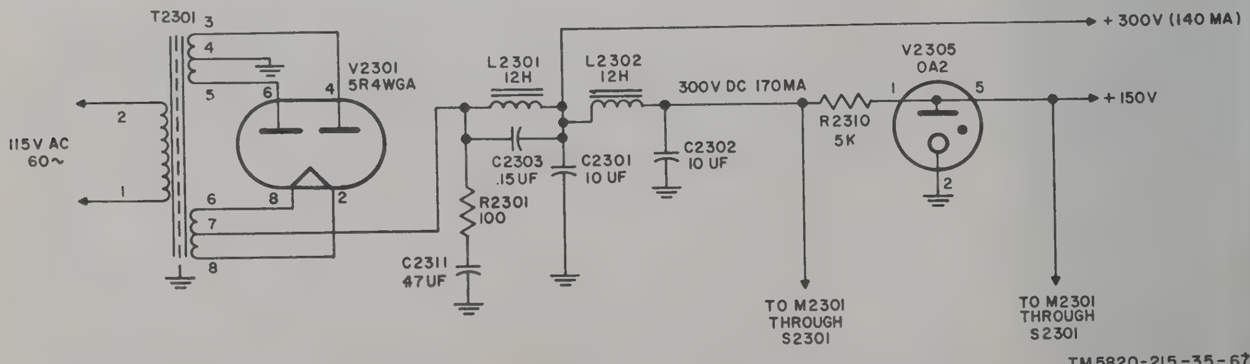

Figure 67. Frequency standard +150- and +300-volt supplies, schematic diagram.

power relay K2302 is energized, contacts 4–5 close and 115 volts ac is applied to plate transformer T2304 (fig. 69). The transformer primaries of T2302 and T2305 are protected by fuses F2304 and F2303. The delay motor is protected by F2306.

98. +28-Volt Supply
(fig. 68)

The +28-volt circuit supplies +28 volts to the automatic tuning motor in the exciter-monitor and the relays that use 28 volts. The 115-volt ac input across the primary of T2302 is stepped down and applied across bridge-connected metallic rectifier CR2301. The bridge circuit rectifies the input voltage and applies the rectified voltage to a choke input filter consisting of L2303-C2304, and bleeder resistor R2302. One output is taken directly off the bridge rectifier and supplies +28 volts at 6 amperes to +28-volt motor B801 (fig. 66). The +28-volt, 1-ampere output of the filter circuit is applied to the various 28-volt relays used throughout the modulator-oscillator group. Fuse F2309 protects the metallic rectifier against overloads in the 1-ampere circuit. The two outputs are also applied to meter M2301 through switch S2301.

99. —105-Volt Power Supply
(fig. 68)

The —105 rectifier circuit supplies the bias potentials for the modulator-oscillator group. The 115-volt ac input across the primary of transformer T2305 appears as 230 volts across the center-tapped secondary. Two metallic rectifiers, connected in a full-wave rectifier configuration, apply the rectified output voltage to the capacitor input filter consisting of C2309, C2310, and L2306. Resistor R2309 is a surge limiting resistor and R2320 is a series current limiting resistor for voltage regulator V2304. Tube V2304 maintains 105 volts across the output of the power supply. The two metallic rectifiers are connected so that the current flow through them produces an output voltage that is negative with respect to ground.

100. +125-, +210-, and +300-Volt Supplies
(fig. 69)

a. This supply consists of a full-wave rectifier circuit that produces an output voltage of +300 volts (at 730 ma). This voltage is applied to two voltage-regulator circuits that produce regulated outputs of +125 and +210 volts.

b. One hundred fifteen volts ac is applied to the primary of T2304 through the closed contacts of filament and plate power relays K2301 and K2302. Fuse F2302 protects the +300-volt circuit against overloading. The center-tapped secondary of T2304 is connected to thyratron-type tubes V2302 and V2303 in a full-wave rectifier circuit. The output voltage of the rectifier is applied to a choke input filter consisting of L2304, L2305, C2305, C2306, C2307, C2308, C2312, R2308, and C2313. Resistors R2304, R2305, R2306, and R2307 dissipate any oscillatory energy that may be developed in the grid circuits of the thyratron tubes. The +300-volt output of the full-wave rectifier is applied to regulator tubes V2306, V2308, and V2309.

c. Tube V2308 functions as a variable resistance that controls the bias applied to series regulator tube V2309A. The circuit is adjusted to produce a +125-volt output across the cathode circuit of V2309A. Tube V2308 is connected between the control grid of V2309A and ground. Resistors R2326, R2327, and R2328 form a voltage-divider network across the +300-volt output that sets the screen grid potential of V2308. The bias on V2308 (and, in turn the output voltage) is determined by the setting of R2332, which is in series with a resistive network (R2331 through R2333) between the +125-volt output and the —105-volt output. This network maintains the grid of V2308 negative with respect to ground. The regulatory action of this circuit functions as follows:

(1) Assume that the +125 output voltage attempts to increase. This increase is coupled through C2315 and increases conduction through V2308.

(2) The increased current through V2308 causes the voltage drop across plate load resistor R2329 to increase and the voltage across V2308 to drop. Since the plate of V2308 is tied directly to the control grid of V2309A, the grid of V2309A becomes less positive with respect to ground and the conduction through V2309A decreases.

(3) The decreased current through V2309A decreases the voltage developed across the cathode circuit and the output voltage drops to compensate for the original increase in output voltage.

d. Resistors R2339 and R2338 form a voltage divider across the +300-volt supply and set the

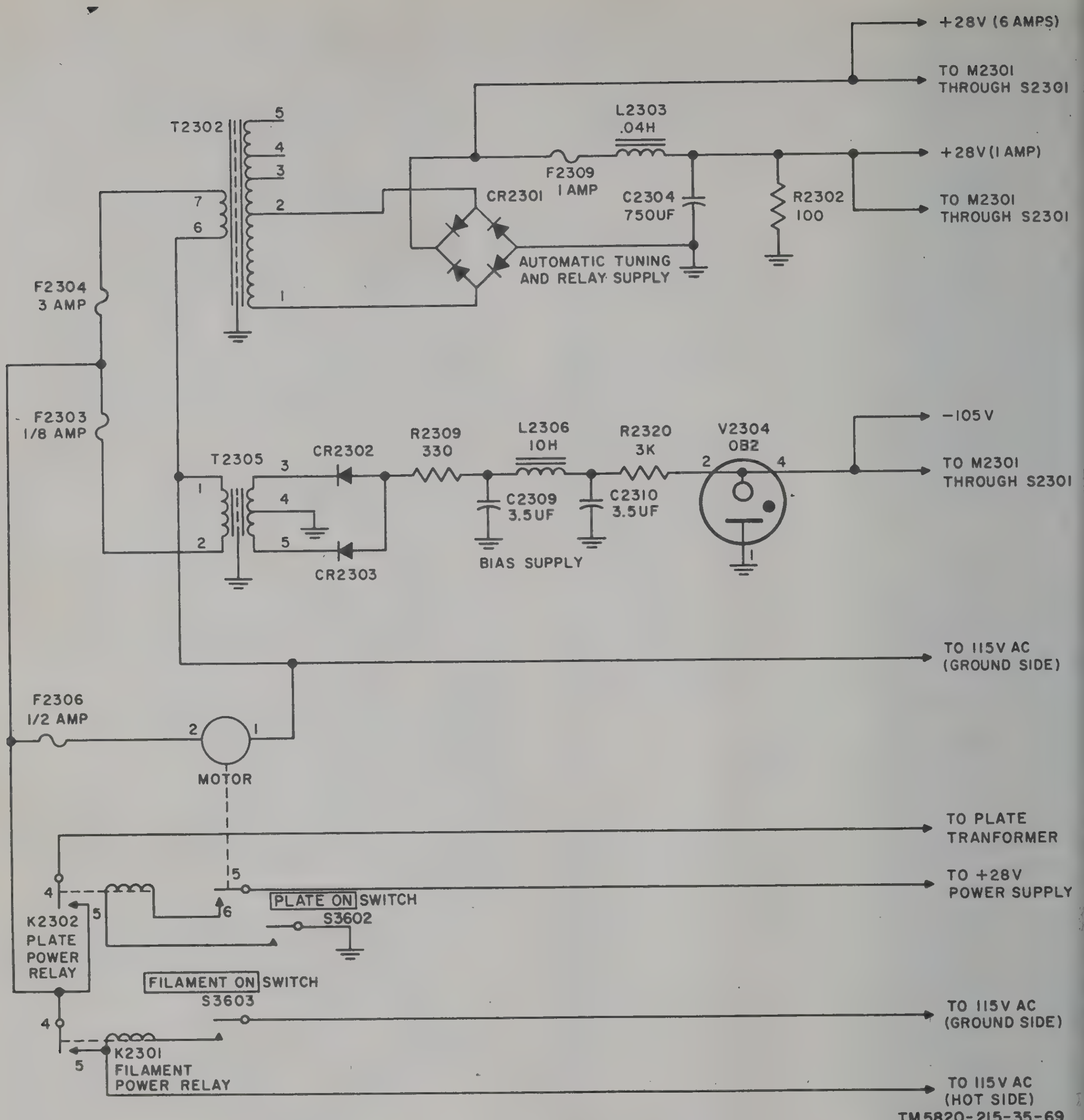

Figure 68. Power input, +28-volt, and —105-volt circuits, schematic diagram.

plate voltage of V2309A. Resistor R2330 is a control grid-return resistor for V2308.

e. Tube V2306 controls the bias on series regulator tube V2309B. The voltage across the cathode of V2309B is adjusted by R2335 to produce an output voltage of +210 volts. Except for part values, this circuit is identical with the one described in *c* above.

f. Filament voltage for V2302 and V2303 is supplied by filament transformer T2303. This filament circuit is protected by F2306. The filament voltage for V2306, V2308, and V2309 is supplied by transformer T2306, which is protected by F2307. One hundred fifteen volts ac is applied to the FILAMENT and PLATE lamps when the FILAMENT and PLATE switches are placed in the ON position.

101. Metering Circuit

(fig. 70)

The metering circuit provides the means fo[r] checking all the output voltages of the power suppl[y]

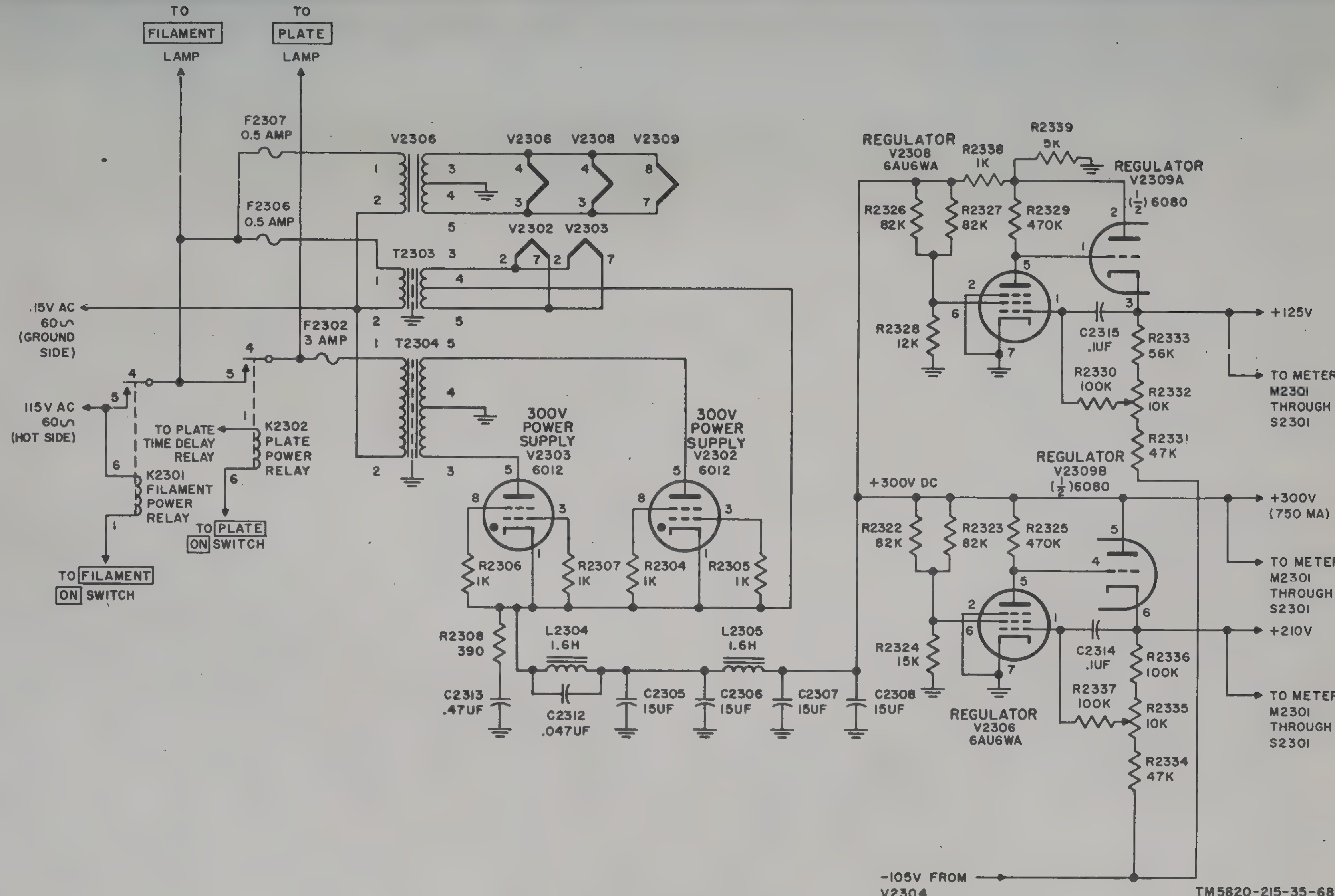

Figure 69. +125-, +210-, and +300-volt supplies, schematic diagram.

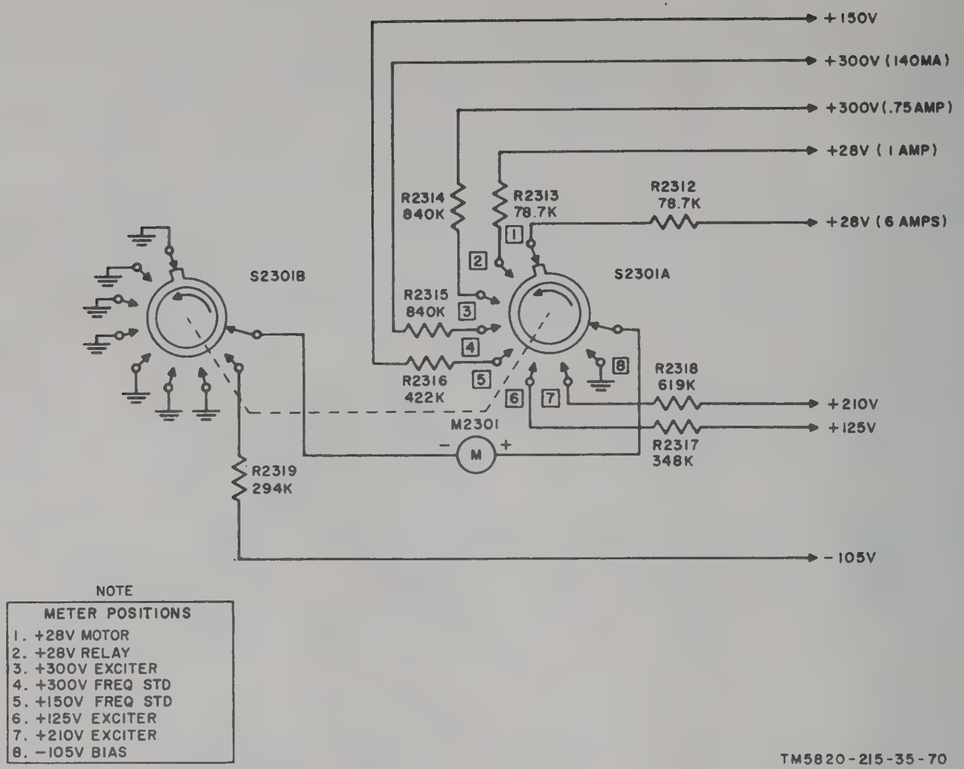

Figure 70. Meter M2301 and switch S2301, partial schematic diagram.

compartment. The meter circuit consists of meter M2301, switch S2301, and multiplier resistors for the various voltages. When the meter switch is placed in position 1 +28V MOTOR, the meter provides an indication of the voltage at the +28-volt supply. Current flows through pin 1 and the wiper of S2301B, through M2301, through the wiper and pin 1 of S2301A, and multiplier resistor R2312. The operation of the meter circuit on other positions is similar except that the current is routed through different contacts of switch S2301.

Section II. POWER SUPPLY CONTROL PANEL

102. FILAMENT Switches
(figs. 71 and 155)

FILAMENT ON pushbutton S3604 is a momentary contact switch that completes the 115-volt ac ground return for pin 1 of filament power relay K2301 (fig. 155). This action energizes the relay and holding contacts 2–3 of K2301 close. Contact 3 of K2301 is returned to the groundend of the 115-volt ac line through normally closed FILAMENT OFF pushbutton switch S3603. When S3603 is pressed, it momentarily opens the ground return path for the relay coil and deenergizes K2301. This action releases the holding contacts (2–3) and the filament circuit can only be energized again by pressing the FILAMENT ON pushbutton.

103. PLATE Switches
(figs. 71 and 155)

The on-off arrangement for the plate circuit is similar to that used for the filament circuit (par. 102) except that plate power relay coil K2302 is powered by +28 volts instead of 115 volts ac. When PLATE ON switch S3602 is pressed, it momentarily completes the ground return for the coil of K2302. This action closes holding contacts 2–3 (fig. 155) and the coil is returned to ground through a jumper placed between terminal 10 and ground of P3812 (fig. 71). When the remote control unit is used, the ground jumper is removed from terminal 10 and placed at the remote unit through a similar normally closed OFF switch. When PLATE OFF

switch S3601 is pressed, it momentarily opens the ground return for the +28-volt relay coil and the holding contacts are released, thereby deenergizing relay K2302.

104. Power Control Panel Lamps
(fig. 71)

Four lamps on the front panel indicate the operating conditions of the modulator-oscillator group.

a. STABILIZED Blue Lamp. Lamp I3604 lights when relay K4801 (fig. 60) is energized (indicating that the smo is turned correctly). Relay K3801 is energized by the +28-volt power supply.

b. FILAMENT Green Lamp. Lamp I3602 lights when filament power relay K2301 (fig. 69) is energized and terminal 4 of P3812 is returned to the 115-volt ac line.

c. PLATE Red Lamp. Lamp I3601 lights when plate power relay K2302 (fig. 69) is energized, thereby returning terminal 5 of P3812 to the 115-volt ac line.

d. LINE Amber Lamp. Lamp I3603 lights when the front-panel LINE switch on the junction box is turned to ON, returning terminal 3 of P3812 to 115 volts ac.

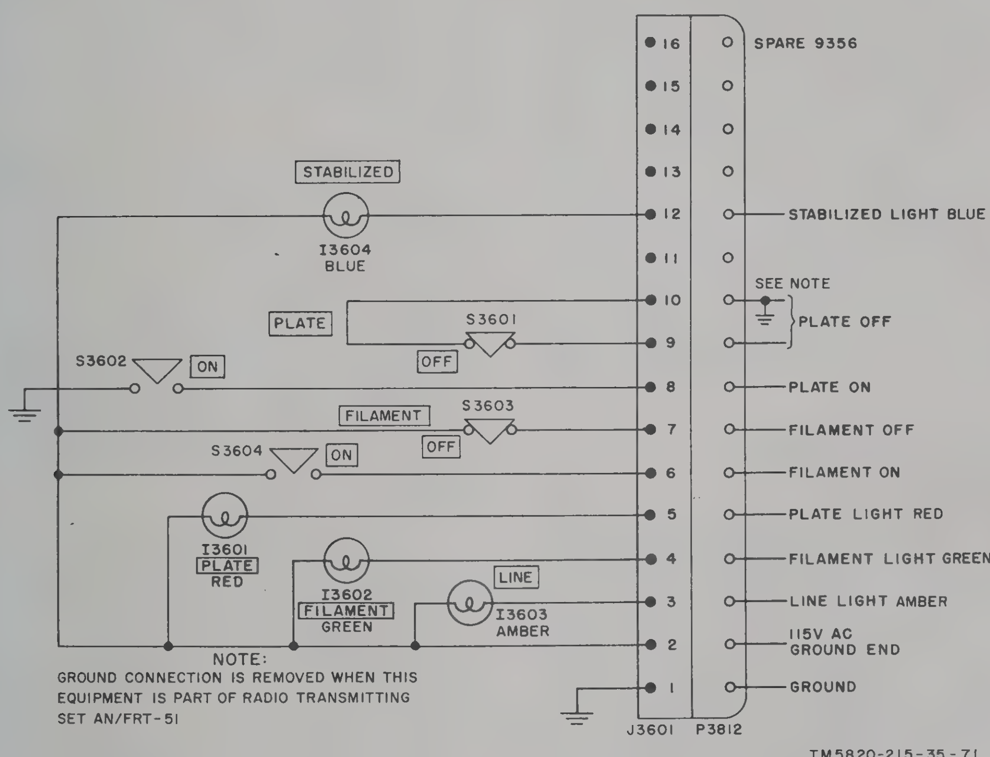

Figure 71. Power control panel, schematic diagram.

Section III. AUTOMATIC LINE VOLTAGE CONTROL PANEL

105. General

The automatic line voltage control panel contains an input autotransformer which permits the use of either 115-volt ac or 230-volt ac primary power. A motor-driven variable autotransformer coupled to the output line through a buck-boost transformer controls the output voltage. The motor is controlled by a stabilized dc bridge circuit with a polarized relay as a sensing element. During manual operation, the bridge circuit is disabled and the variable autotransformer is operated manually by the control knob on the front panel.

106. Output Voltage Control Circuit
(fig. 72)

a. When this equipment is used as part of Radio Transmitting Set AN/FRT-51, the input voltage to this panel is 115 volts ac. This voltage is applied

between the neutral terminal and terminal 1 of T9501. Autotransformer action steps up the 115-volt input to 230 volts across the entire transformer (terminals 1 and 4). When the input voltage is 230 volts ac, it is applied between terminals 1 and 4 of T9501. In either case, the voltage across T9501 is 230 volts ac.

b. The 230-volt ac voltage across T9501 is applied directly across terminals 2 and 4 of T9503. The secondary (terminals 3 and 4) of T9502 is in series with the output voltage. The primary (terminals 1 and 2) of T9502 is driven by the voltage appearing between the variable arm of T9503 and the fixed tap (terminal 6). When the variable arm is on one side of the fixed tap, the voltage appearing in the secondary of T9502 is series aiding the voltage across terminals 1 and 2 of T9501, thereby increasing the output voltage. When the variable arm is on the other side of the fixed tap, voltage in the secondary of T9502 is reversed in phase and is in series opposition with the voltage across terminals 1 and 2 of T9501, thereby reducing the output line voltage. Meter M9501 indicates the output line voltage. When switch S9501 is in the MANUAL position, the variable arm on T9503 may be adjusted manually to provide the desired output voltage.

107. Stabilized Bridge Circuit
(fig. 72)

a. When switch S9501 is placed in AUTOMATIC the stabilizing bridge circuit automatically controls the position of the arm on T9503. The output line voltage is applied through adjustable resistor R9502 and fixed resistor R9503 across a voltage-doubling circuit consisting of CR9501, CR9502, C9502 and C9503. Rectifier CR9501 conducts on the positive input half-cycle, charging C9503; and CR9502 conducts on the negative half-cycle, charging C9502. The rectified voltage across the two capacitors is approximately twice the value of the input voltage.

b. The rectified voltage across C9502 and C9503 is applied across two terminals of the bridge circuit consisting of V9501, V9502, R9506, and R9507. When the output voltage is correct, the voltage across V9501 equals the voltage drop across R950 In this condition, the bridge circuit is in balanc and no voltage appears across differential rela K9501.

c. If the voltage applied to the bridge circuit i higher than that required for balance, more cu rent flows through voltage-regulator type tub V9501 and V9502 because the resistance of thes tubes drops. Since the voltage across V9501 re mains constant, the increased voltage drop acros R9506 unbalances the bridge. In this conditio terminal 1 of K9501 is positive with respect t terminal 5 and contacts 6 and 8 close, energizin the counterclockwise winding of B9501. Driv motor B9501 moves the arm of variable aut transformer T9503 in a direction to decrease th output line voltage, decreasing the voltage applie to the bridge circuit until the bridge is brought int balance.

d. If the voltage applied to the bridge is belo that required for balance, less current flows throug V9501 and V9502 because the resistance of th tubes increases. Since the voltage across V950 remains constant, the reduced voltage drop acro R9506 unbalances the bridge. In this conditio terminal 5 of K9501 is positive with respect t terminal 1, contacts 2 and 8 close, energizing th clockwise winding of B9501. Drive motor B950 moves the arm of T9503 in a direction to increa the output line voltage.

e. The setting of R9502 determines the amount output line voltage applied to the voltage-doubli rectifier circuit and thus controls the line volta level at which the bridge balances. This control normally set to the point at which the output li voltage stabilizes at 115 volts ac. SENSITIVIT control R9501 determines the amount of resistan in series with the coils of K9501, which in tur determines the voltage differential required operate K9501, and thus controls the sensitivity the control circuit. This control is normally set maximum sensitivity except where rapid fluctuatio in input voltage cause excessive hunting and whe the allowable output line voltage variations a more than ±1 volt.

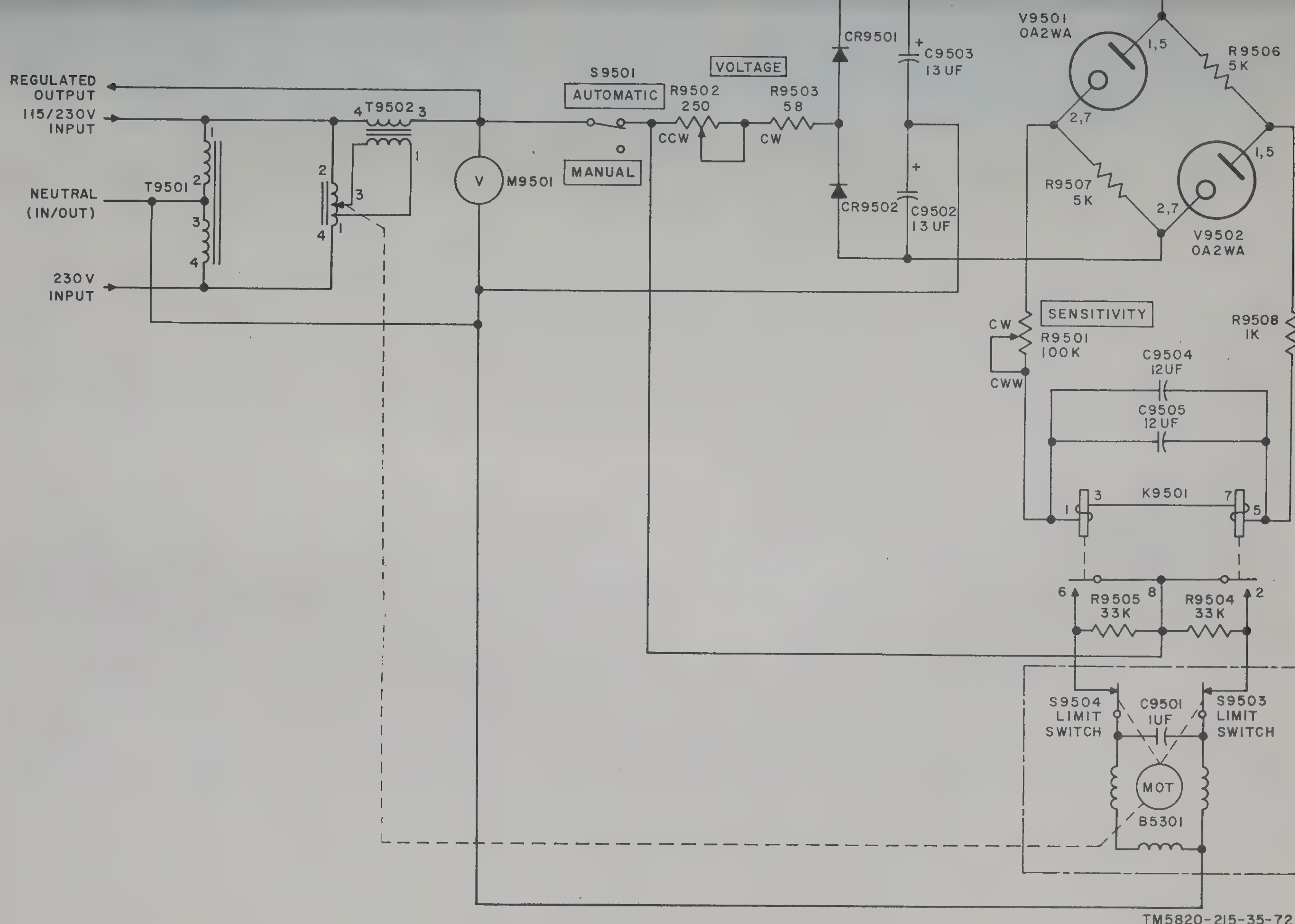

Figure 72. Stabilized bridge circuit, schematic diagram.

CHAPTER 6

TROUBLESHOOTING

Section I. GENERAL PROCEDURES

Warning: **Operation of this equipment involves the use of high voltages which are dangerous to life. When this equipment is used as part of the Radio Transmitting Set AN/FRT–51 system, certain troubleshooting, alinement, and testing operations require energization of the equipment with the cabinet doors or drawers open, exposing the high-voltage points. Whenever a door interlock, shorting switch, or other protective device is blocked or otherwise disabled, there is extreme danger to maintenance personnel. Do not disable the protective devices unless it is absolutely necessary; remove all disabling equipment, such as interlock blocks, immediately after the maintenance procedure is complete. Do not leave the equipment location while protective devices are disabled. Always ground circuits before touching them. Do not service alone. Do not depend on door interlocks and grounding switches for protection. Turn the equipment off whenever it is not absolutely necessary to operate the equipment while making measurements or tests.**

108. General Instructions

Troubleshooting at the field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in TM 11–5821–212–20. The systematic troubleshooting procedure, which begins with the operational checks that can be performed at the organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques. In this equipment, the third echelon repairman is authorized to make all electrical repairs except the audio level meter, which he is authorized to replace only. Refer to TM 11–5820–215–20P for a complete list of maintenance allocations.

109. Troubleshooting Procedures

a. General. The first step when servicing the modulator-oscillator group is to sectionalize the fault. Sectionalization means tracing the fault to a compartment responsible for the abnormal operation of the modulator-oscillator group. The second step is to localize the fault. Localization means tracing the fault to the defective subchassis and stage responsible for the abnormal conditions. The final step is to isolate the defective part. Some faults caused by burned-out resistors, arcing, and shorted transformers, often can be localized by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and waveshapes at test points.

b. Fault Sectionalization, Localization, and Isolation. Listed below is a group of tests arranged to simplify and reduce unnecessary work and to aid in tracing a trouble to a specific component. The simpler tests are used first. Those tests that follow are more complex. For example, the trouble is traced to a compartment of the modulator-oscillator group (tsb modulator, exciter-monitor, power supply control, automatic line voltage control, power supply, or the junction box and blower filter assembly) (sectionalization). Then the trouble is traced to a subchassis and stage within the compartment (localization). The faulty component in that compartment is located (isolation), and the trouble is remedied. The service procedure is summarized as follows:

(1) *Visual inspection.* Visual inspection enables the repairman to locate faults without testing or measuring circuits. A

meter readings or other visual signs should be observed. This inspection is valuable in avoiding additional damage that might occur through improper servicing methods and in forestalling future failures.

(2) *Resistance measurements.* The use of resistance measurements to locate trouble will prevent further damage to the equipment if possible short circuits are present. The normal resistance values at any point can be determined by using the schematic diagrams to calculate the resistance values and by the use of the resistor color code (fig. 155). Before making any resistance measurements, turn off the power.

(3) *Voltage measurements.* In addition to the front-panel meters that indicate all power supply voltages and key voltages through the modulator-oscillator group, test points are located in this equipment that provide easy access to the grid, cathode, and plate circuits of various stages. The voltage values at these test points are listed in paragraph 120 along with references to waveforms where such information is applicable. Compare the readings obtained with the normal readings shown.

(4) *Operational test.* The operational test is performed by following the procedures of the equipment performance checklist in TM 11–5821–212–20. It is important because it frequently indicates the general location of the trouble. In many instances, the information gained will determine the exact nature of the fault. To use this information fully, interpret all symptoms in relation to one another.

(5) *Troubleshooting charts.* The trouble symptoms listed in the troubleshooting charts in paragraphs 114 through 118 will aid greatly in localizing trouble.

10. Troubleshooting Data

Always check the circuit labels. The schematic iagram in the manual may not include circuit hanges made during equipment production. Use the naterial supplied in this manual, and the equipment erformance checklist and tube location diagrams in 'M 11-5821–212–20. Consult troubleshooting data n the chart below.

a. Illustrations.

Description	Fig. No.
Modulator-oscillator, location of subchassis	7, TM 11–5821–212–10
Frequency standard:	
Front panel	8, TM 11–5821–212–10
Tube location	38, TM 11–5821–212–20
Top views	79, 80
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b. Equipment Differences. Some minor differences in component values exist in this equipment. Notes on illustrations define these differences and list the serial numbers of the equipments that are affected.

111. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting the modulator-oscillator is listed below.

Nomenclature	Common name
Ammeter ME–65/U	Ammeter
Analyzer, Spectrum TS-723/U	Spectrum analyzer
Audio Oscillator TS-382/U (2)	Audio oscillator
Capacitive Voltage Divider HP–453A	Capacitive voltage divider
Frequency Meter AN/URM–79	Rf meter
Frequency Meter AN/URM–80	Vhf meter
Multimeter ME–77/U	ME–77/U
Multimeter, Meter ME–26/U	ME–26B/U
Oscilloscope OS-8A/U	Oscilloscope
Resistance Bridge ZM–4/U	Resistance bridge
Test Set, Electron Tube TV–2/U	TV–2/U
Test Set, Electron Tube TV–7/U	TV–7/U
Voltmeter, Meter ME-30A/U	ME–30A/U
Tool Equipment TE–113	Tools

112. Preliminary Tests

With the modulator-oscillator connected for normal operation, operate it as described in the applicable portions of the equipment performance checklist in TM 11–5821–212–20. Listen for crackling or buzzing noises that indicate high-voltage arcing. Fuses on the front of the power supply compartment protect the equipment against filament and B+ shorts. Check for smoke and the odor of burned or overheated parts. If smoke or odor is present, turn the set off immediately to prevent further damage to the modulator-oscillator.

Section II. TROUBLESHOOTING CHARTS AND TEST POINT MEASUREMENTS

113. Intercompartment Troubleshooting

Each compartment (with the exception of the power supply control and the blower filter assembly) is equipped with at least one front-panel meter that indicates the conditions within the compartments. A defect in the modulator-oscillator group may cause severe distortion in the output, an error in the output frequency, or no output at all. Faulty operation of a compartment can be detected by comparing the front-panel meter readings with those in the troubleshooting chart for the compartment. If no immediate symptoms are noticed, check the compartments in the following order.

a. Power supply.

b. Automatic line voltage control.

c. Frequency standard.

d. Tsb modulator.

e. Exciter-monitor.

114. Use of Troubleshooting Charts

a. The troubleshooting charts supplement the operational checks detailed in the equipment performance checklist (TM 11–5821–212–20). If previous checks have isolated the defective compartment go directly to the troubleshooting chart for that compartment. If no operational symptoms are known, begin with item 5 of the equipment performance checklist and proceed until the trouble is located.

b. The *Correction* column indicates, in general the components or circuits to be checked or adjusted if the measurement is abnormal. When the *Correction* column lists a test point, reference should be made to the paragraph where the test point is listed. Check the circuit components associated with the test point where the measured voltage is abnormal

115. Power Supply Troubleshooting Chart
(figs. 73, 74, 75, 155, 156, and 159)

Symptom	Normal reading on panel meter	Probable trouble	Correction
1. All filaments off, FILAMENT and PLATE indicator lamps extinguished.		No power applied to power supply.	Check connections to terminals 10 and 27 of J2301. The voltage between these two terminals should be 115 volts ac. Check connections in junction box. Check connections to J3601 in power control panel and switches S3601 through S3604 (fig. 75).
2. All filaments except V2301 are extinguised.		Defective filament power relay K2301.	Check K2301.
3. No exciter-monitor plate voltages; other voltages normal.		Defective plate power relay K2302, plate time-delay relay K2303, defective fuse F2302.	Check K2302, K2303, F2302.
4. Low or no voltage with panel meter set to +28V MOTOR position.	10	Defective fuse F2304, rectifier CR2301, or resistor R2312.	Check F2304, CR2301, R2312, and check connections at J2301.
5. Low or no voltage with panel meter set to +28V RELAY position.	10	Defective F2304, F2305, CR2301, L2303, R2302, or R2313.	Check F2304, V2305, CR2301, L2303, R2302, and R2313.
6. Low or no voltage with panel meter set to +300V EXCITER position.	10	Defective F2302, V2302, V2303, or +300-volt filter, or voltage-regulator component.	Check F2302, V2302, V2303, check filter and voltage-regulator components.
7. Low or no voltage with panel meter set to +300V FREQ STD position.	10	Defective tube or filter component in V2301 supply.	Check F2301, V2301, and filter circuit components.
8. Low or no voltage with panel meter set to +150V FREQ STD position.	10	Defective voltage regulator V2305 or R2310.	Check R2310, V2305. Check connection at J2301.
9. Low or no voltage with panel meter set to +125V FREQ STD (step 6 normal).	10	Defect in V2308 or V2309A control circuits.	Check V2308, V2309A; adjust R2332; check circuit components.
10. Low or no voltage with panel meter set to +210V EXCITER position (step 6 normal).		Defect in V2306 or V2309B control circuits.	Check V2306, V2309B; adjust R2335; check associated circuit components.
11. Low or no voltage with panel meter set to −105V BIAS.	10	Defect in filament power relay K2301 or in bias power supply.	Check K2301, F2303, CR2302, CR2303, V2304, and filter components.

116. Automatic Line Voltage Control Troubleshooting Chart
(figs. 76, 77, 78, and 160)

Symptom	Probable trouble	Correction
1. No voltage indicated on LINE VOLTAGE meter.	No input voltage. Defect in T9501, T9502, or T9503. Defective voltmeter M9501.	If an input voltage of 230 volts ac is used, check at terminals 1 and 4 of T9501. If an input voltage of 115 volts ac is used, check at terminals 1 and 2 of T9501. If input voltage is normal, check T9501, T9502, T9503, and M9501. Replace defective component.
2. LINE VOLTAGE pointer constantly fluctuating.	Excessive hunting of automatic system.	Readjust SENSITIVITY control R9501.

Symptom	Probable trouble	Correction
3. Line voltage may be regulated manually but does not regulate when set to AUTOMATIC.	Incorrect setting of VOLTAGE control R9502.	Readjust control adjustment R9502.
	Defect in automatic line voltage circuit.	Replace V9501 and V9502. Check CR9501, CR9502, C9502, and C9503. Check differential relay K9501 and associated components. Check clockwise and counterclockwise windings of motor B9501. Check limit switches S9503, S9504, and associated circuit components.

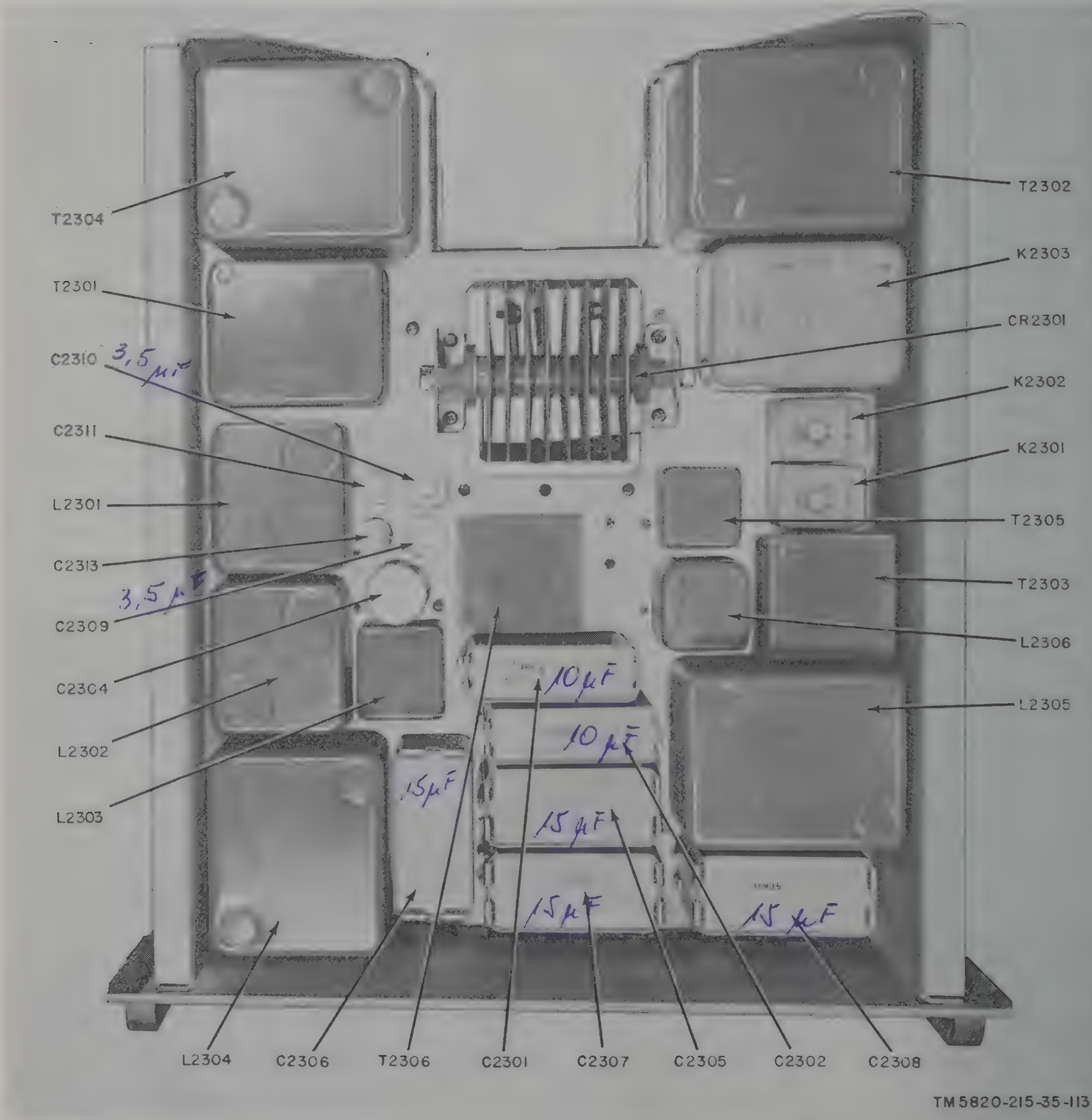


Figure 73. Power supply, top view, location of components.

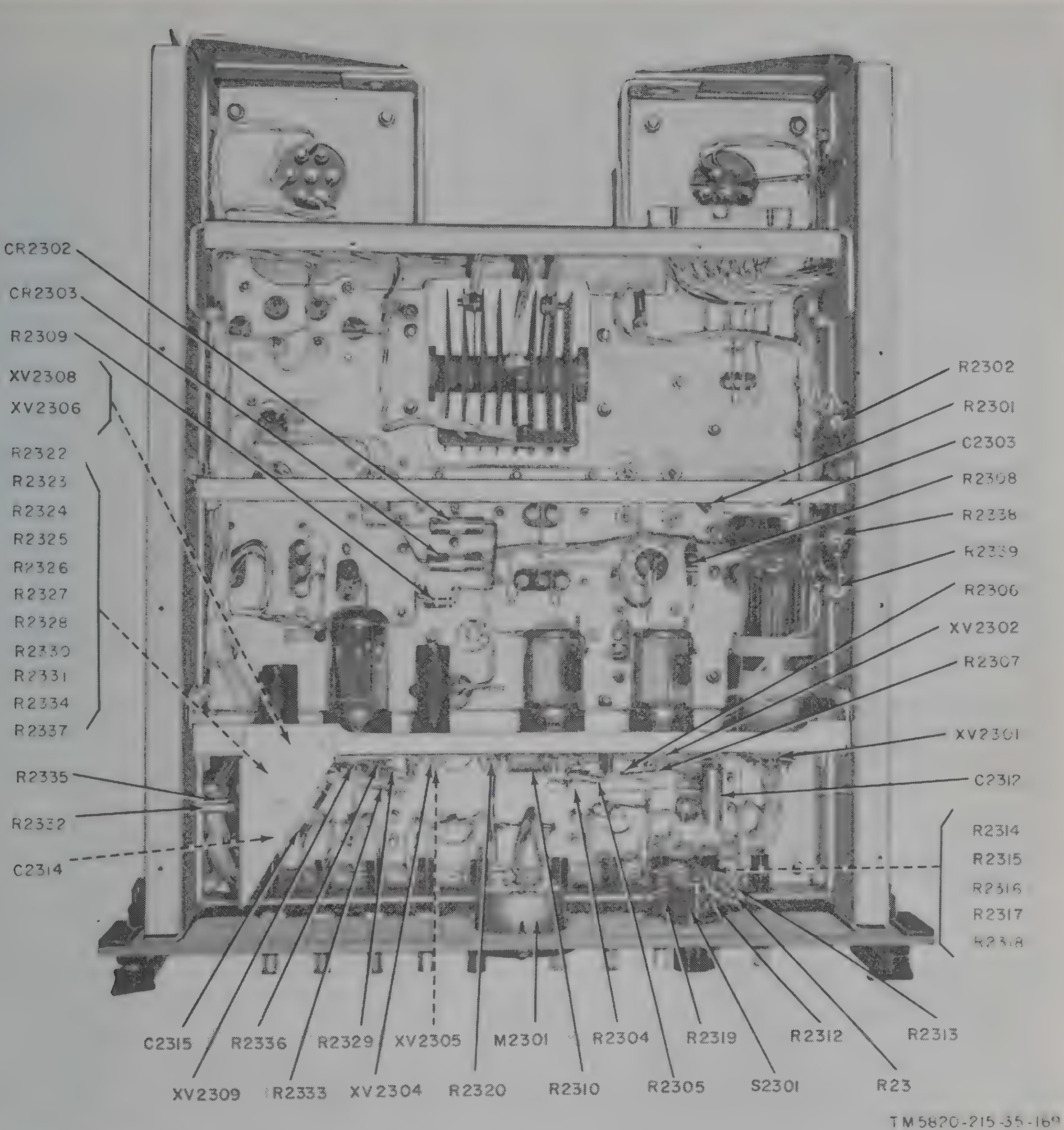


Figure 74. Power supply, bottom view, location of components.

117. Frequency Standard Troubleshooting Chart

(figs. 79 through 90; and 149)

Symptom	Probable trouble	Correction
1. Front-panel meter indicates less than 6 with meter switched to 900 KC DIV, 300 KC DIV, or 100 KC DIV position.	No 1-mc input voltage. Defect in mixer V901 or frequency tripler V902 circuits.	Check for 1-mc input at TP901. Input voltage should be 4 volts rms when measured with an ME–26/U. If input voltage is normal, check V901 and V902 circuit. Refer to paragraph 119*a* and make voltage measurements at TP902, TP903, TP904, TP911, TP912, and TP913.

Symptom	Probable trouble	Correction
2. Front-panel meter indicates less than 3 with meter switched to OVEN-OSC. (If oven has been on for less than 3 hours, meter indication should be 8.)	Defect in oven control circuit.	Check CR601 and heater HR601. Refer to paragraph 119*a* and make voltage measurements at TP605, TP606, and TP607.
3. Front-panel meter indicates less than 2 or more than 6 with meter switched to 1 MC OSC position.	Defective crystal oscillator Y601 or V601. Defect in oscillator amplifier V602, V603, or V604.	Check Y601 by replacing with a known good crystal. Refer to paragraph 119*a* and make voltage measurements at TP602, TP603, and TP604.
4. Front-panel meter indicates less than 4.9 or more than 5.1 with meter switched to 100 KC GEN position.	No 100-kc input to V503. Defective V503 circuit component.	Remove P501 and check for 100-kc output at J903 with ME-26/U hf probe. Voltage at TP503 should be +7.8 volts when measured with the ME–26/U. If input is normal check V503 circuit. Refer to paragraph 119*a* and make voltage measurements at TP514 and TP515.
5. Front-panel meter indicates less than 4.9 or more than 5.1 with meter switched to 250 KC GEN, or 75/100 KC position.	No 100-kc input to V501. Defect in V501, V502, or V504 circuit.	Check for +0.6 volt at TP504. If voltage is normal, refer to paragraph 119*a* and check TP501 through TP507, TP511 through TP517.
6. Front-panel meter indicates less than 4.9 or more than 5.1 with meter switched to 5 KC position.	No 25-kc input or defective mixer-multiplier V1301, CR1303, or circuit component.	Check for 25-kc input at TP1301. Input voltage should be 30 volts rms when measured with an ME–26/U. If input voltage is normal, refer to paragraph 119*a* and check waveform and voltage at TP1303.
7. Front-panel meter indicates less than 6.5 or more than 6.7 with meter switched to 1 KC DIV position.	No 10-kc input from CR1303. Defective mixer-multiplier V1302 or circuit component.	Check cathode (pin 3) voltage of V1302 at TP1312. The measurement should be +10 volts. If this voltage is normal, refer to paragraph 119*a* and check TP1305 and TP1306.
8. Front-panel meter indicates less than 2.9 or more than 3.1 with meter switched to 1.5 KC GEN position.	No 1-kc input from CR1304. Defect in V4701 or V4702 circuit.	The voltage at the cathode of V4702 (measured at TP4701) should be +4 volts when an input is present. Check V4701 and V4702 stages. If the voltage is normal, refer to paragraph 119*a* and check TP4703.
9. Front-panel meter indicates less than 3.9 or more than 4.1 with meter switched to 4.5 KC GEN position.	No 500-cycle input from Z4701. Defect in V4703 circuit.	Check V4702 circuit. Refer to paragraph 119*a* and check TP4702.

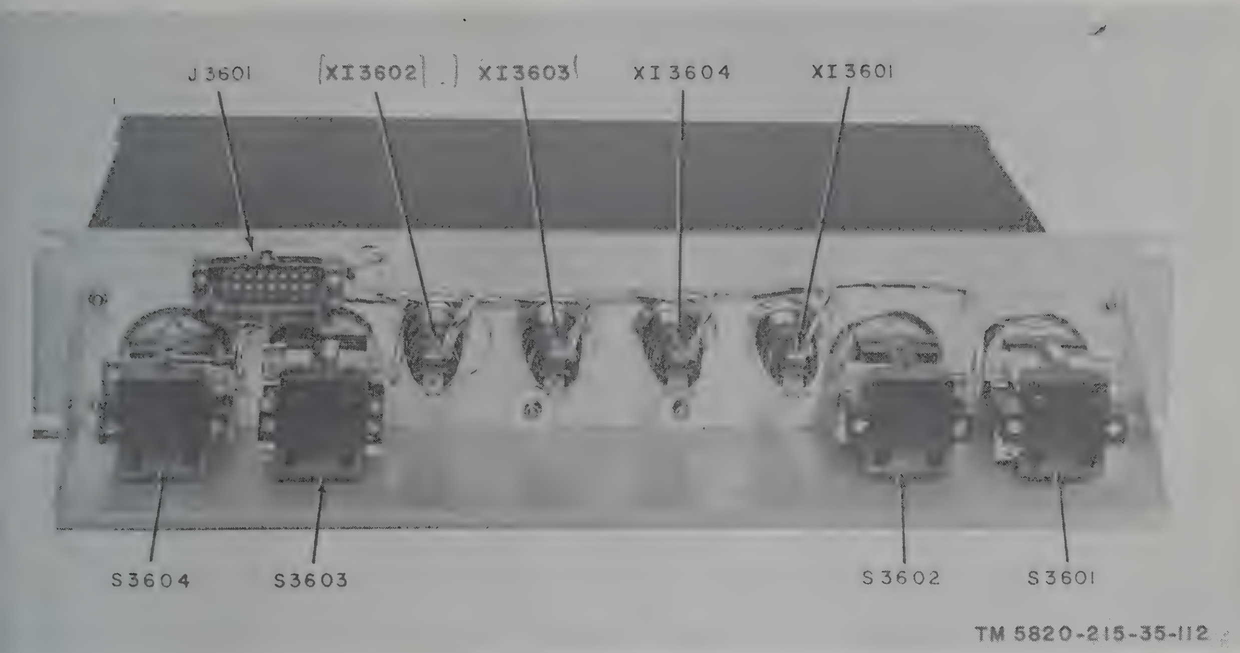


Figure 75. Power supply control panel, rear view.

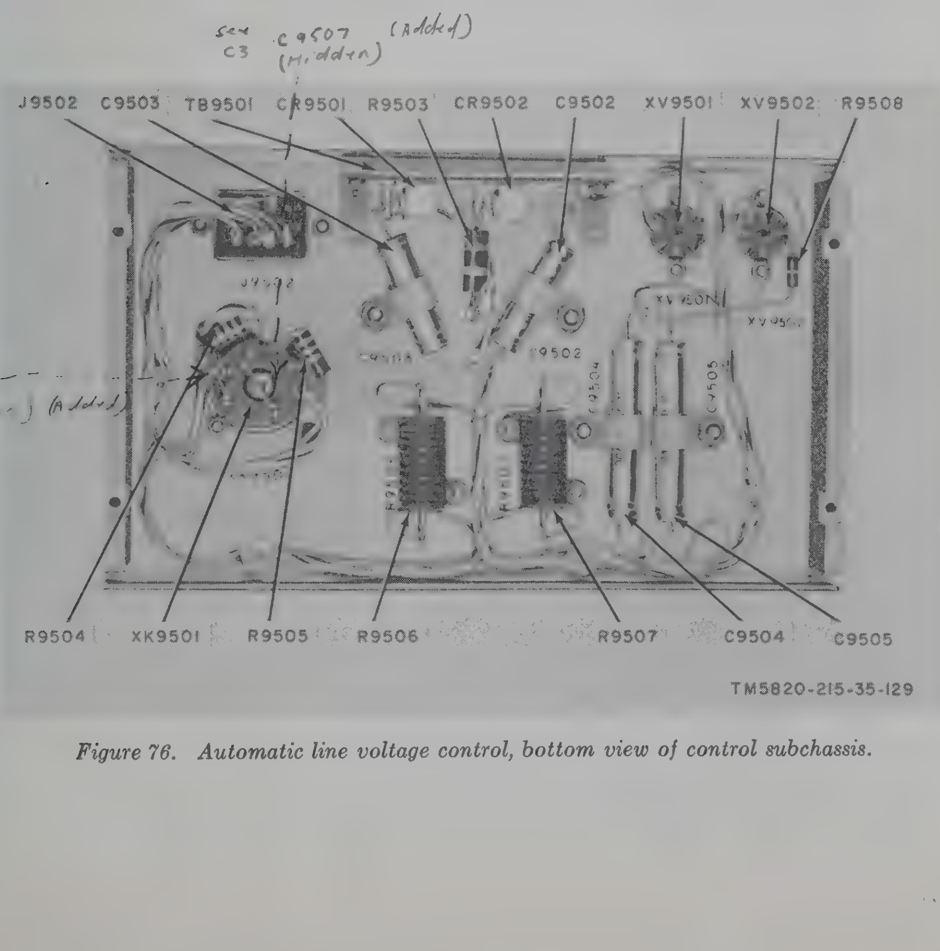


Figure 76. Automatic line voltage control, bottom view of control subchassis.

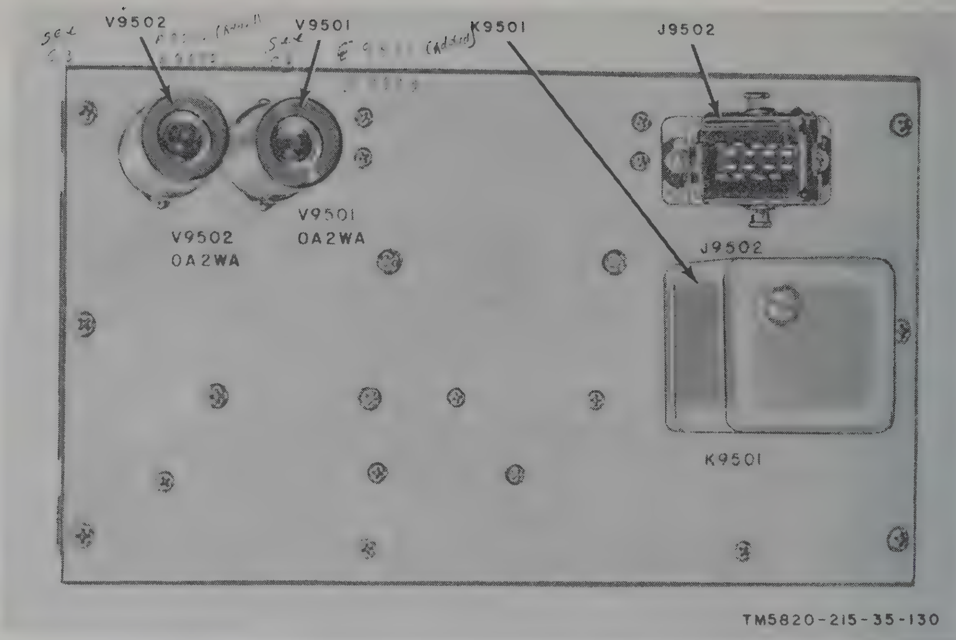


Figure 77. Automatic line voltage control, top view of control subchassis.

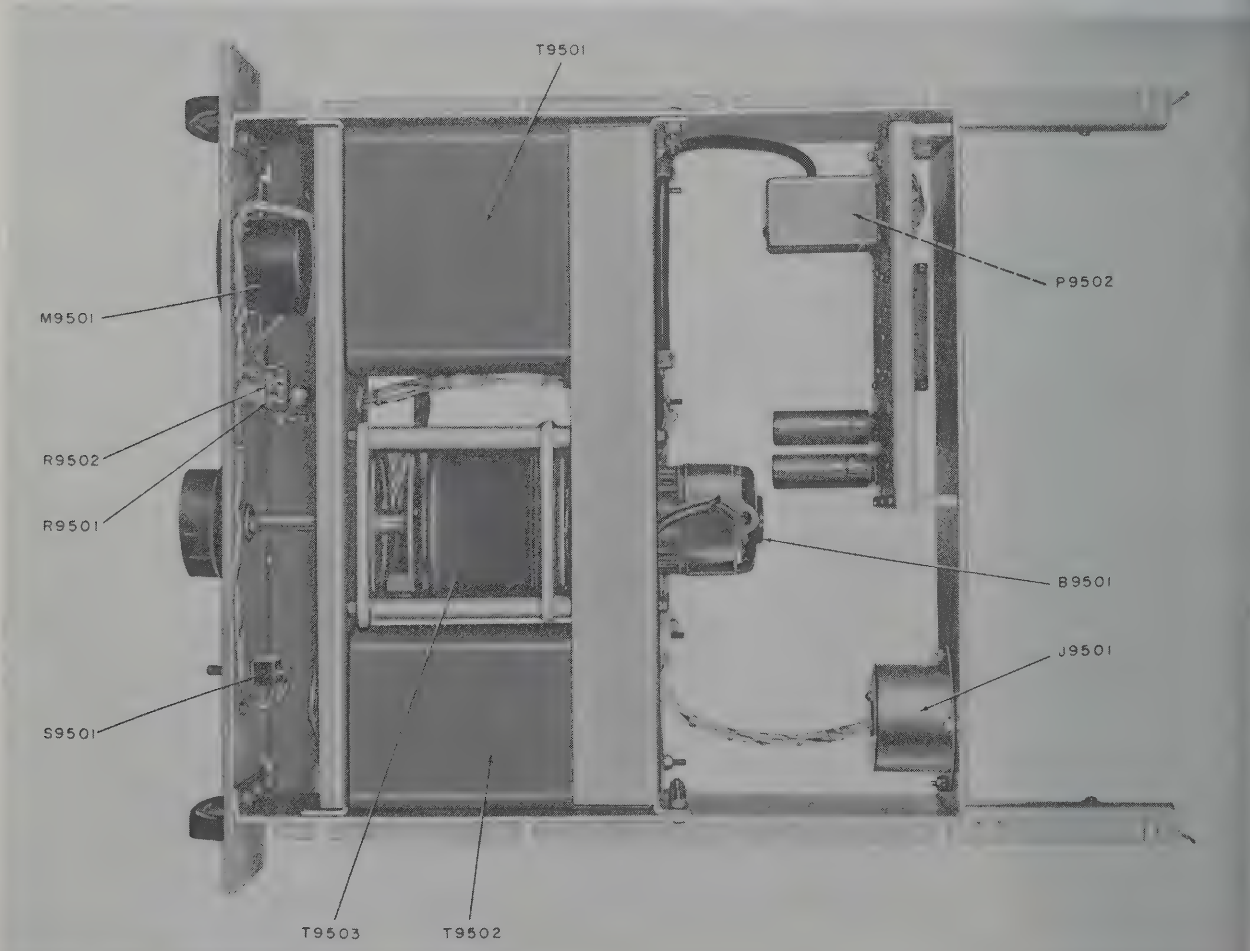


Figure 78. Automatic line voltage control panel, bottom view.

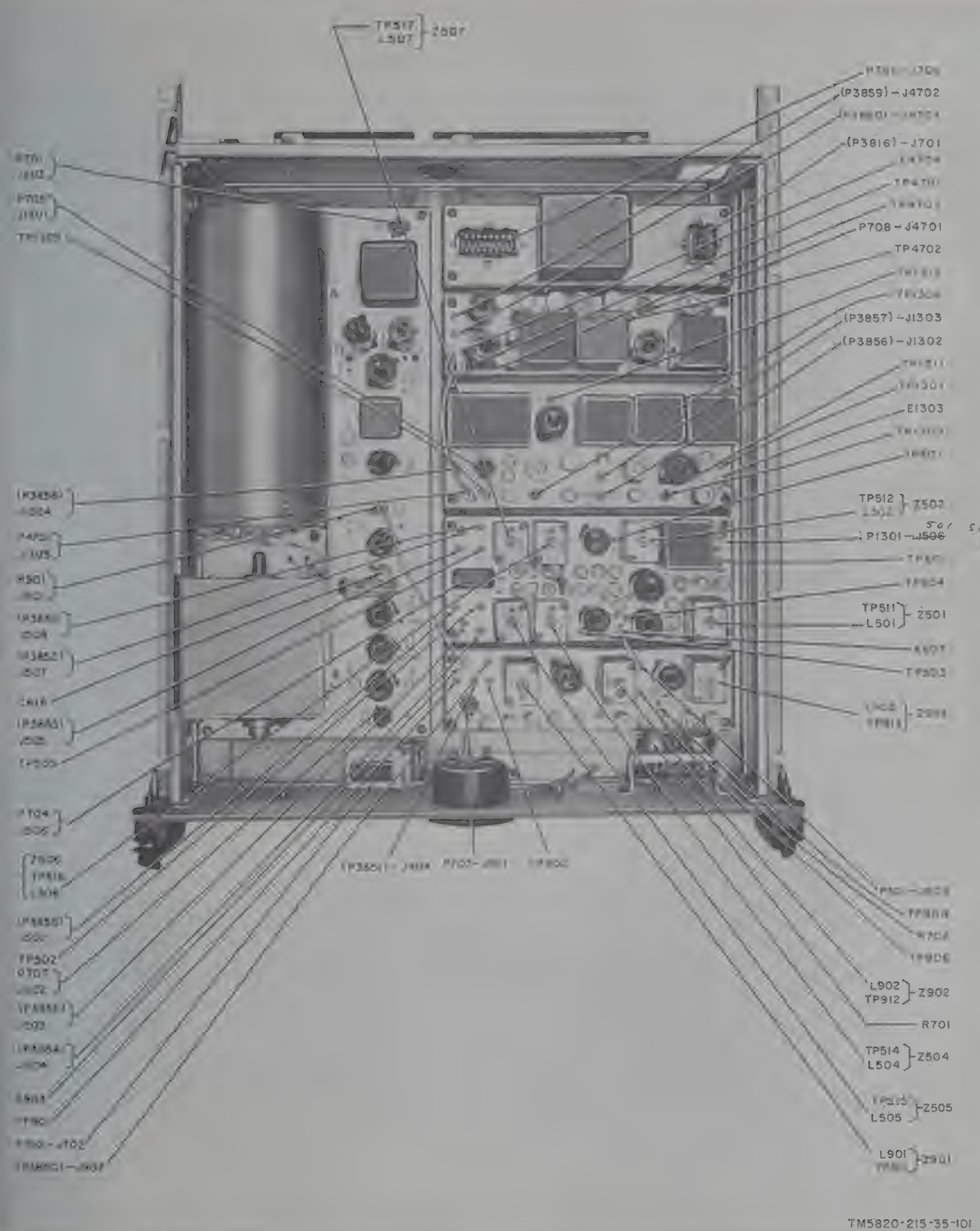


Figure 79. Frequency standard, top view showing test points and plug and jack locations.

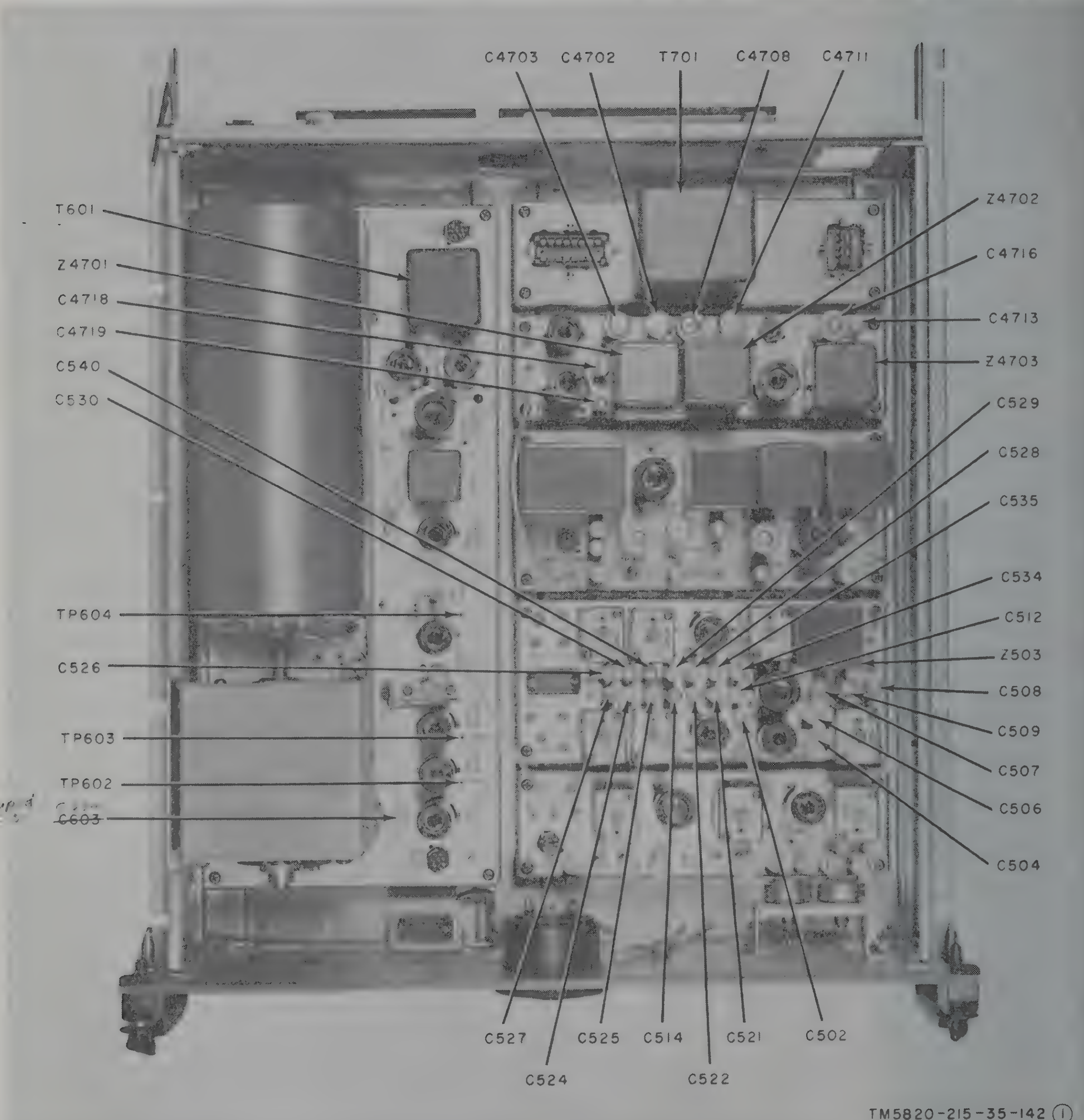


Figure 80. Frequency standard, top view showing capacitors (Part 1 of 2).

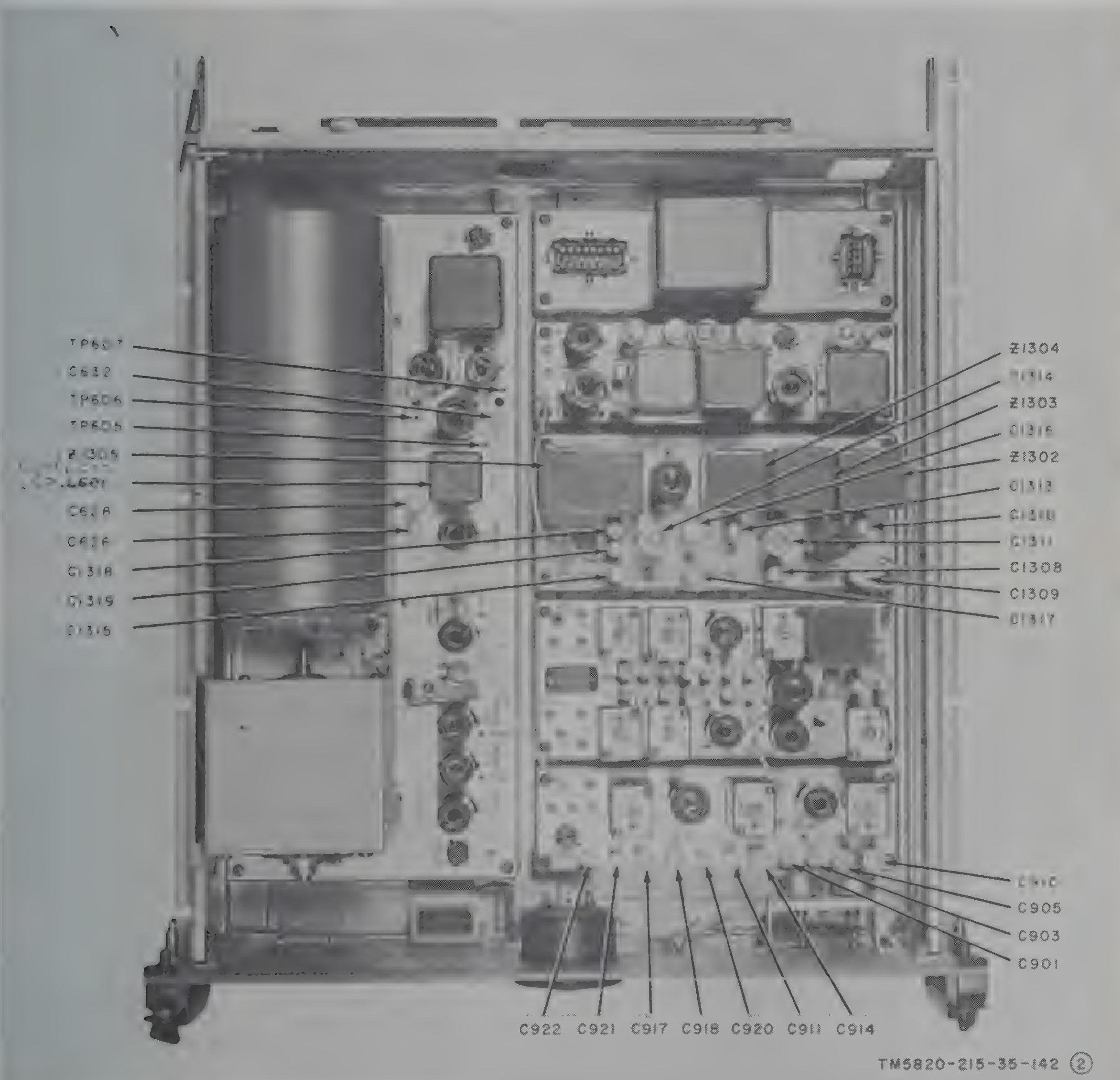


Figure 80—Continued *(Part 2 of 2).*

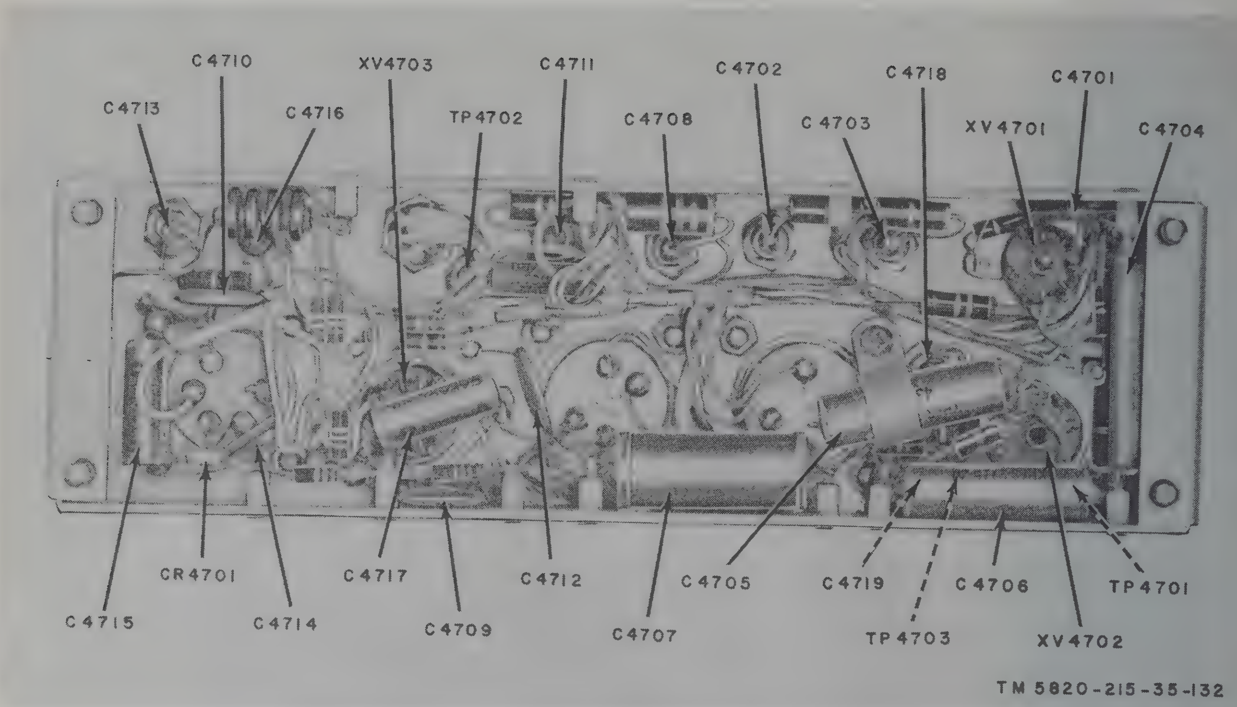


Figure 81. 4.5-kc generator, bottom view showing capacitors.

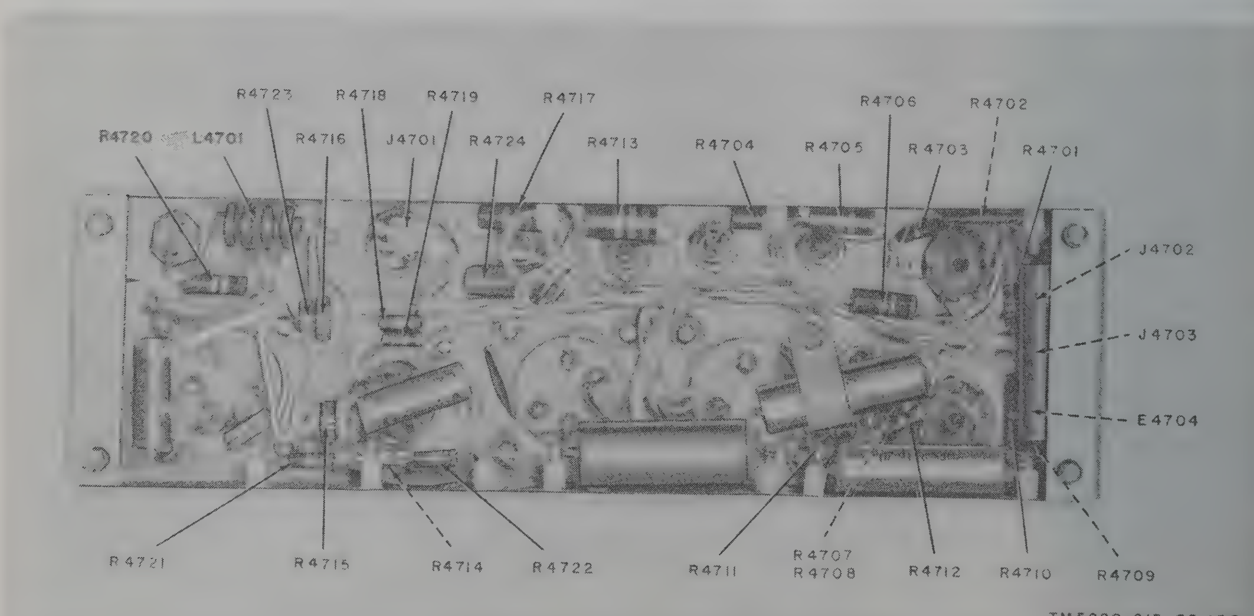


Figure 82. 4.5-kc generator, bottom view showing resistors.

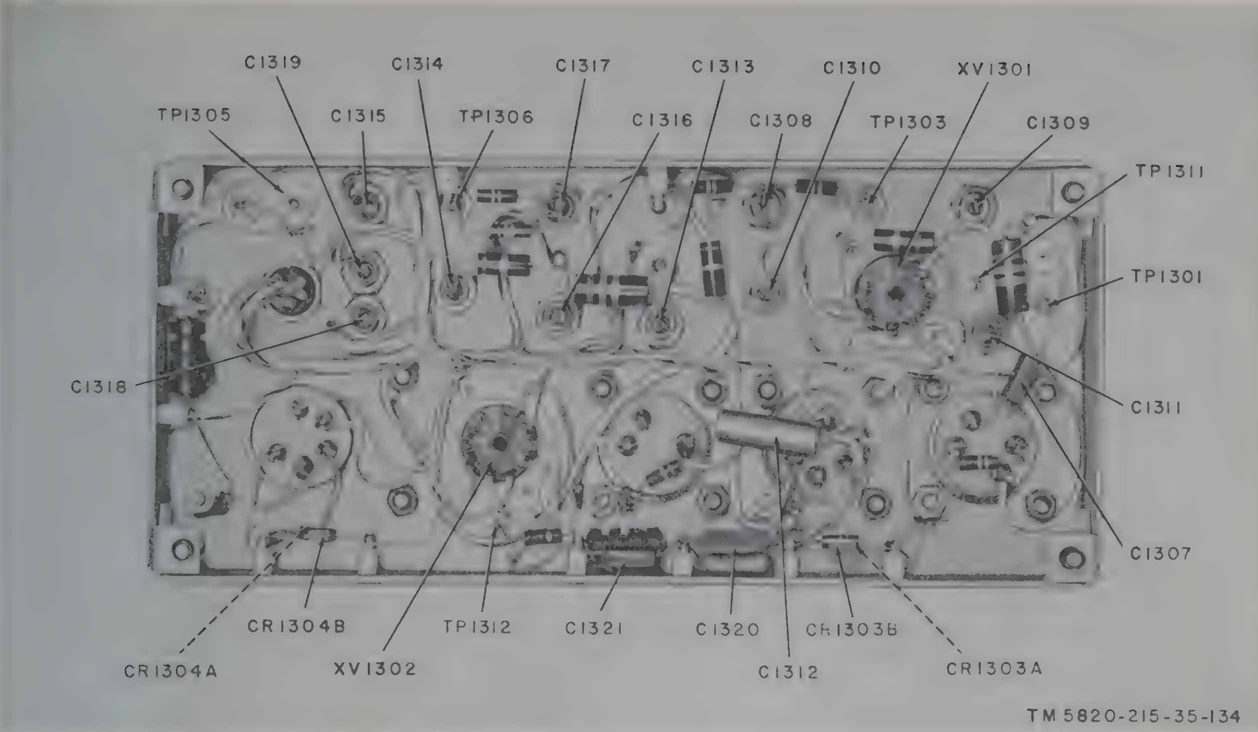


Figure 83. 25- to 1-kc divider, bottom view showing capacitors.

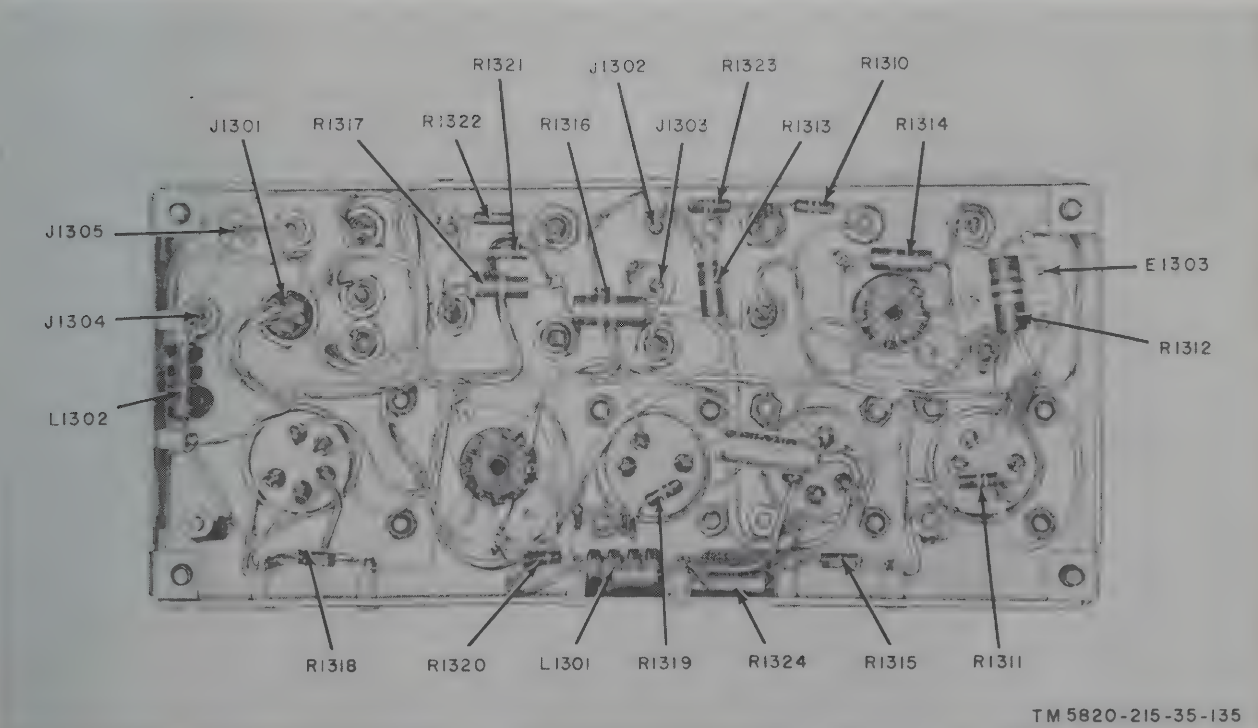


Figure 84. 25- to 1-kc divider, bottom view showing resistors.

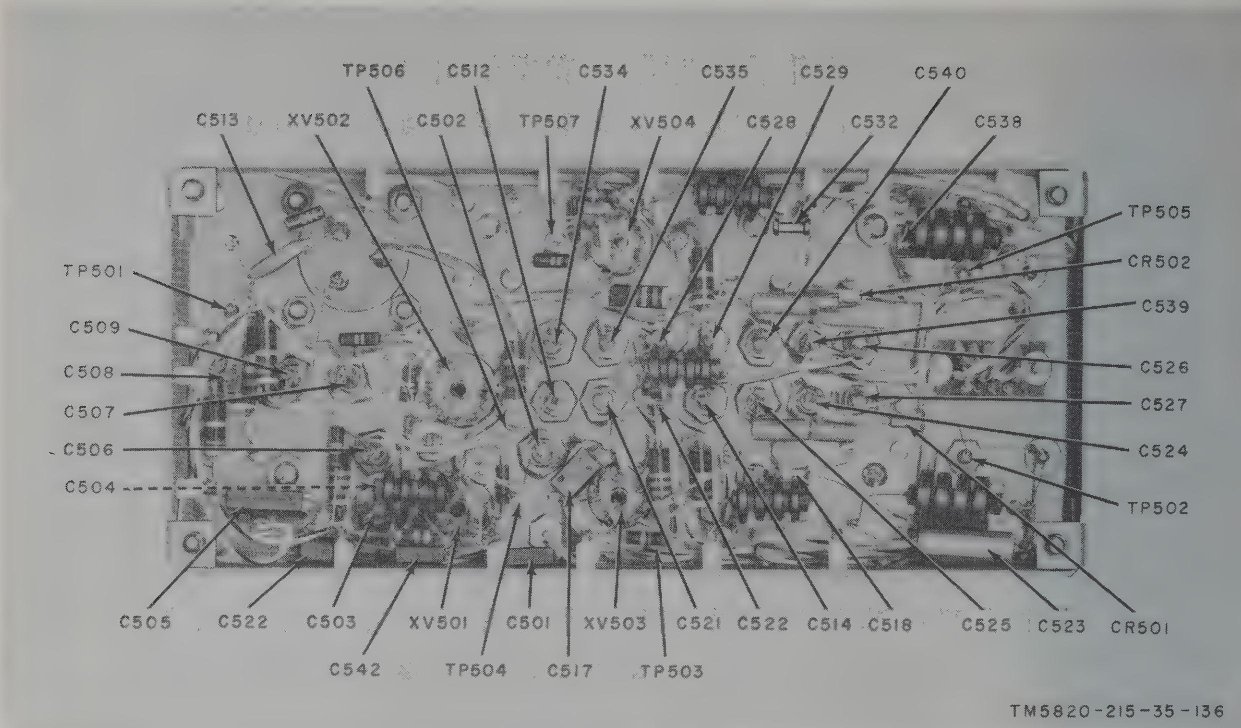


Figure 85. 100- and 250-kc generator, bottom view showing capacitors.

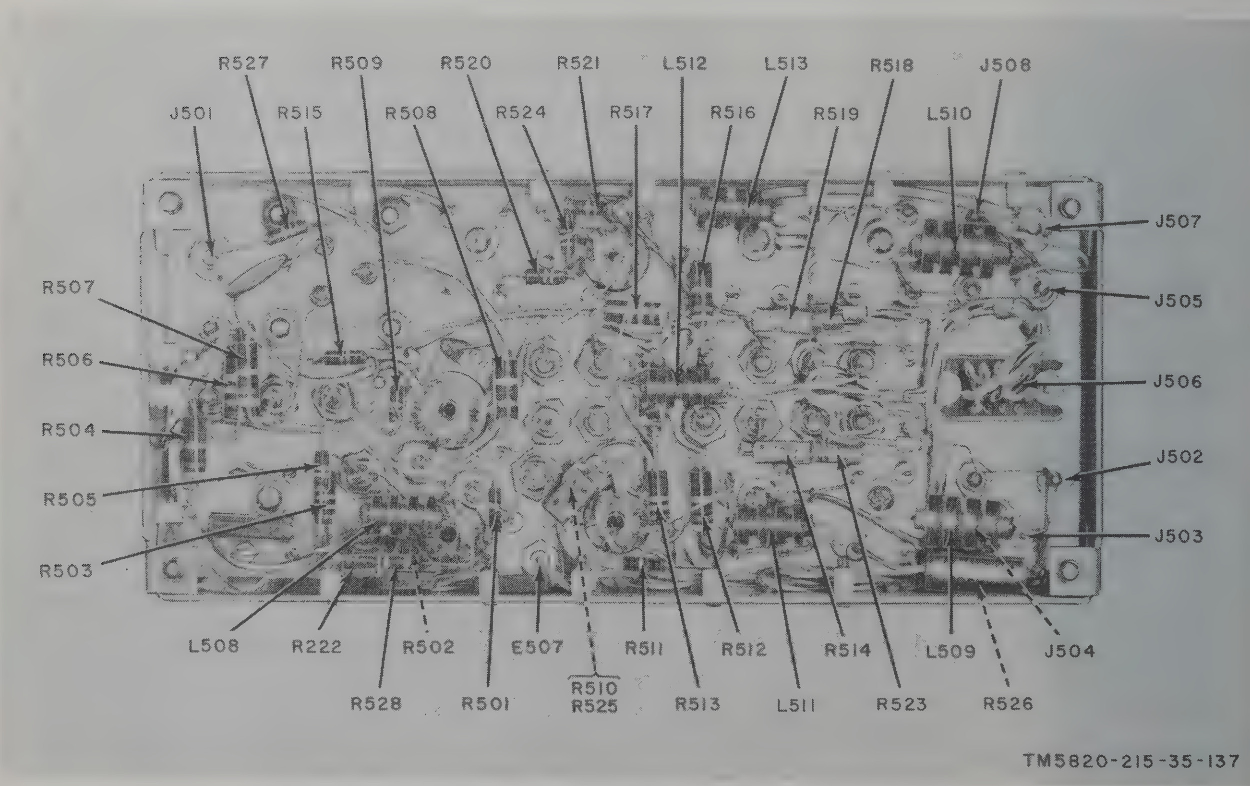


Figure 86. 100- and 250-kc generator, bottom view showing resistors.

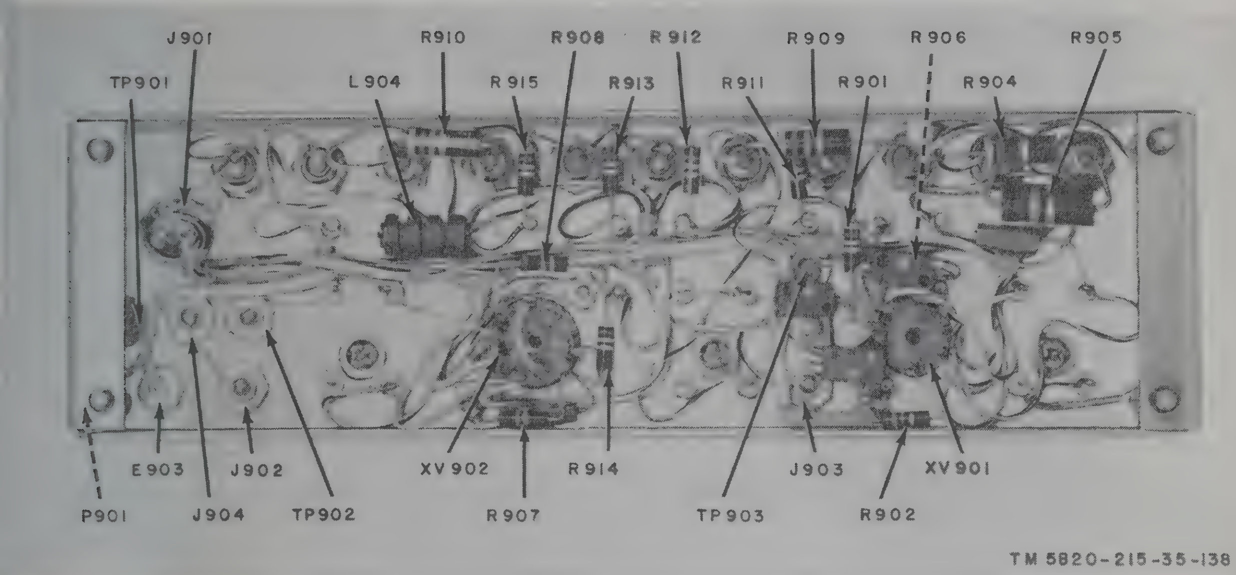


Figure 87. 1-mc to 100-kc divider, bottom view showing resistors.

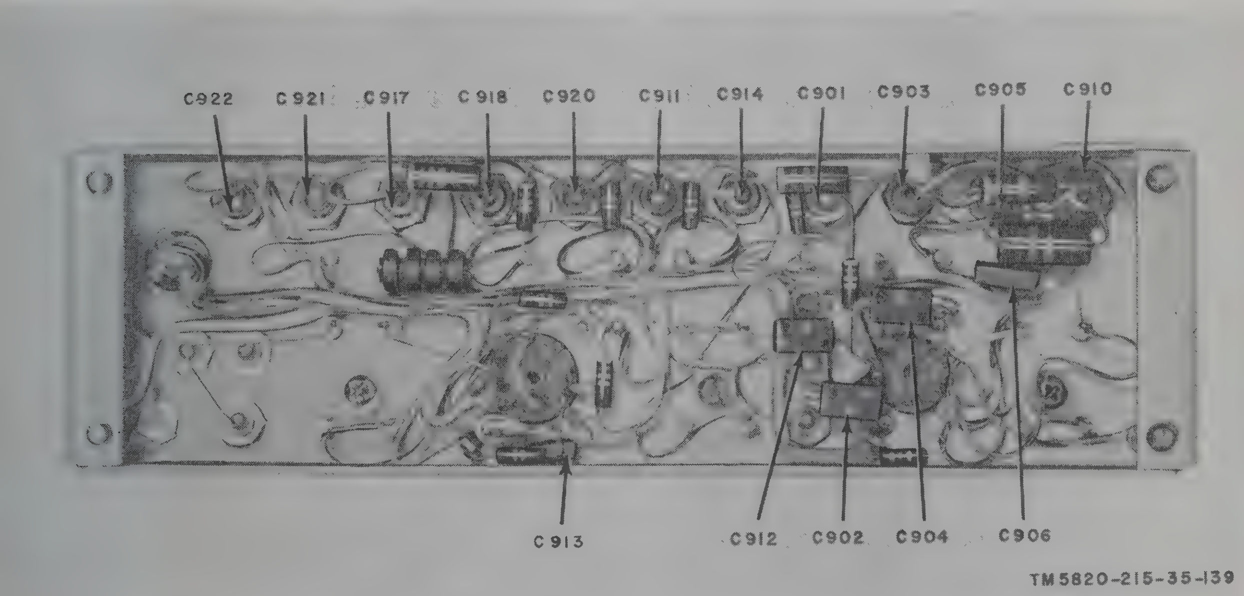


Figure 88. 1-mc to 100-kc divider, bottom view showing capacitors.

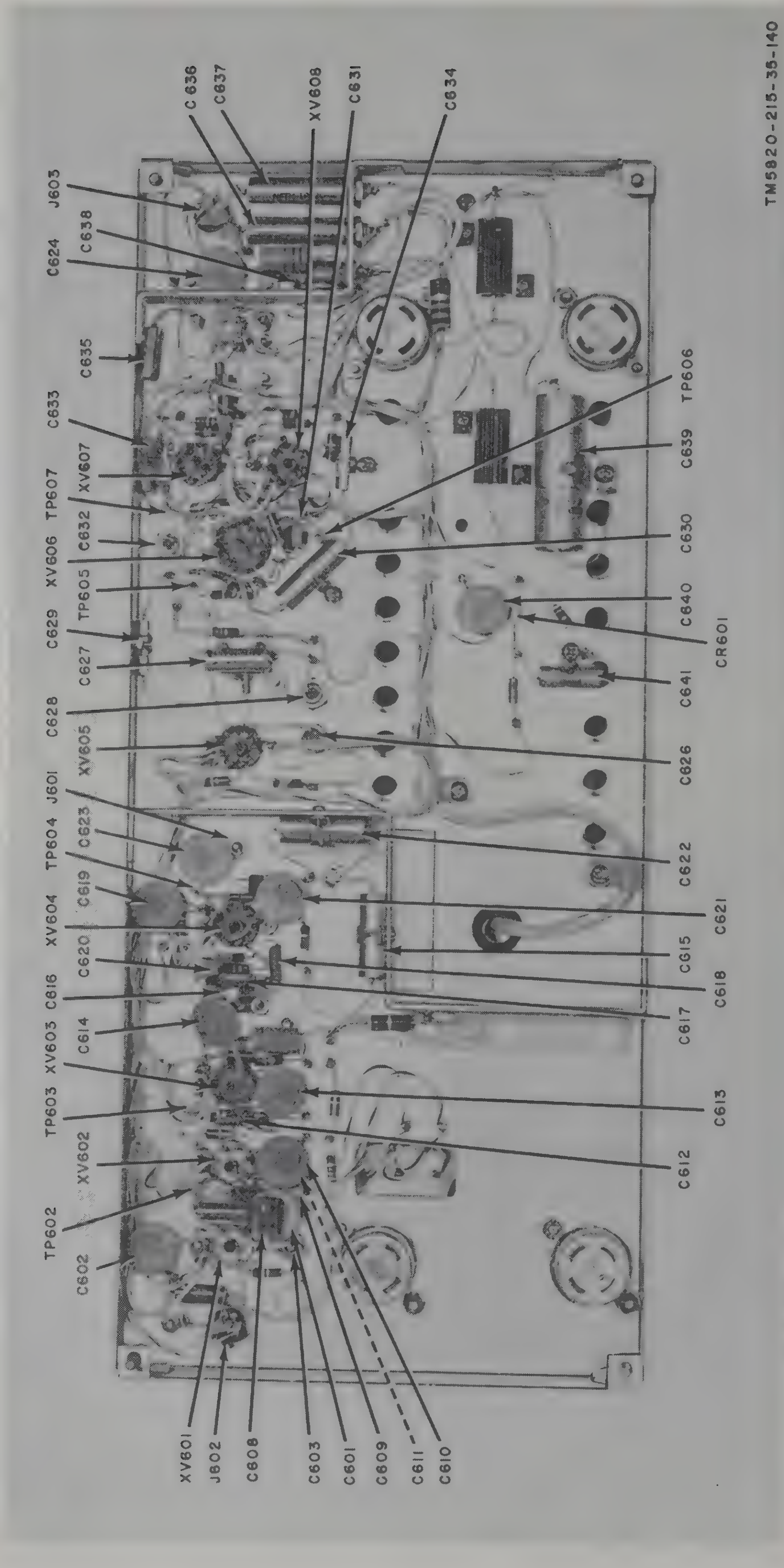


Figure 89. 1-mc crystal oscillator and oven control subchassis, bottom view showing resistors.

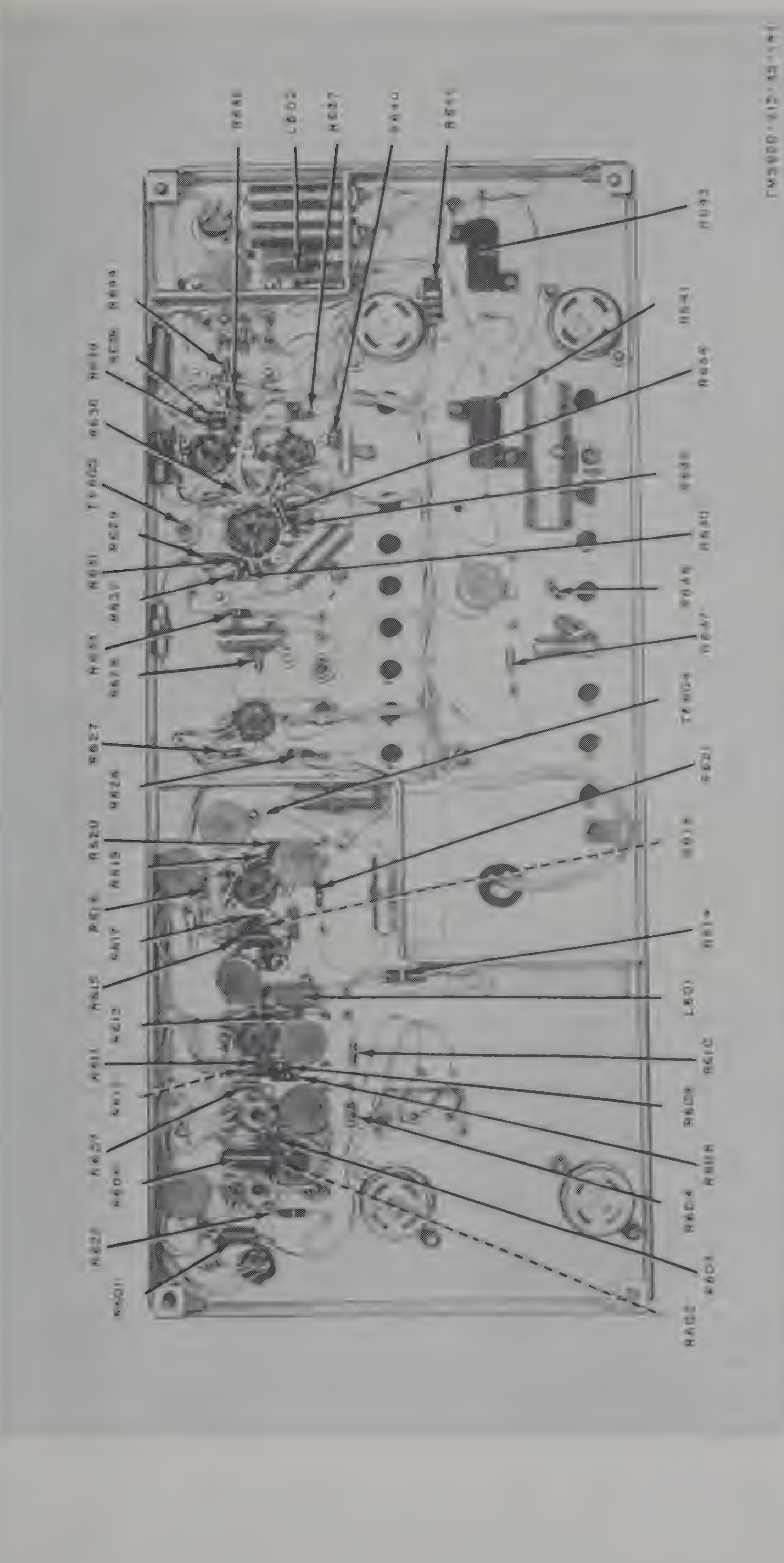


Figure 90. 1-mc crystal oscillator and oven control subchassis, bottom view showing capacitors.

118. Tsb Modulator Troubleshooting Chart

(figs. 91 through 102, and 150)

The tsb modulator contains two panel meters that indicate the signal level of the input signals to both audio lines. These meters do not aid in troubleshooting this compartment. When trouble in the modulator-oscillator group is sectionalized to the tsb modulator compartment, begin the troubleshooting procedure by checking for the presence of the 100-kc pilot carrier applied to the input of the tsb generator subchassis. If the pilot carrier is present and V201 is conducting, 130 volts rms can be measured at TP201. If this check indicates that the pilot carrier is present, proceed to troubleshoot the various subchassis as listed in the troubleshooting chart below. Unless otherwise specified, use the ME–26/U for all voltage measurements. Starting at step 6, apply one tone of a standard two-tone test signal. Refer to paragraph 120 for test point voltage listing.

Symptom	Probable trouble	Correction
1. Voltage at TP207 less than +1.2 volts dc.	Reinsert carrier relay K201 defective. Defect in V201 stage.	Check K201. Refer to paragraph 119*b* and check voltages at test points TP207 and TP201. Check associated circuit components.
2. Signal voltage at TP201 less than 130 volts rms.	Defect in Z201.	Check Z201 and associated circuit.
3. Signal voltage at TP201 normal but no voltage at TP202 and TP203.	Defect in limiters CR201 through CR204 or associated circuit component.	Check and replace defective crystal rectifier CR201 through CR204. Check associated circuit components.
4. Tube V202 normal (2 volts dc measured at TP202) but no voltage, or excessively high voltage at TP203.	Defect in V203 circuit.	Check V203 circuit and T209.
5. Tube V203 normal (2 volts dc measured at TP203) but no voltage, or excessively high voltage at TP202.	Defect in V202 circuit.	Check V202 circuit and T206.
6. Signal at TP4201 less than 0.017 volt rms (measured with an ME–30A/U).	Defect in balanced modulator or crystal filter circuit.	Check crystals CR205 through CR208; check sideband filters Z204 and Z205 by replacement; check T203 and T204 and associated circuit components. Check audio input. Start with transformer panel and check for audio at output of T9601 and T9602. Check through modulator attenuator networks R4001 through R4006; check for audio inputs to T205 and T208.
7. 100-kc signal at TP4101 normal but no 200-kc component at TP4112.	Defect in input circuit to frequency multiplier V4101.	Check Z4101, C4101, C4104, R4102, Z4101, Z4102, V4101, and associated circuit components.
8. Input voltage to V4101 normal but no voltage at TP4113.	Defect in V4101 or Z4103.	Check voltage at TP4102. Check V4101, Z4103, and associated circuit components.
9. Signal voltage at TP4113 normal but no signal voltage at TP4114.	Defect in Z4104.	Check Z4104 and associated circuit components.
10. Inputs to V4201 normal (signal from tsb generator at TP4201 and signal from frequency multiplier at TP4103) but voltage at TP4202 below normal.	Defect in frequency converter V4201.	Check V4201 and associated circuit components.
11. Cathode voltage of V4201 normal (measured at TP4202) but no signal output at TP406.	Defective 6-kc filter Z4202.	Check Z4202 and coupling components.
12. 300-kc input signal at TP406 normal but no voltage at TP407, with alc switch in OFF position.	Defect in coupling components or in V401 circuit.	Check CR401, V401, and associated circuit components.

Symptom	Probable trouble	Correction
13. Voltage at TP407 normal but no signal voltage at TP401.	Defect in Z401.	Check Z401 by replacement.
14. Signal voltage at TP401 normal but no signal at TP402.	Defective coupling component or Z402.	Check C407, C419, Z402.
15. Signal at TP402 normal but no-voltage at TP404.	Defect in second controlled gain amplifier V402.	Check V402 and associated circuit components.
16. Voltage at TP404 normal but no signal at TP403.	Defect in coupling component or in Z403.	Check C412, Z403, and associated circuit components.
17. Signal voltage at TP4501 normal but no voltage at TP4502.	Defect in agc amplifier V4501.	Check V4501 and associated circuit components.
18. Voltage at TP4502 normal but no voltage at TP4503 (AGC switch set to BAL).	Defect in CR4501 or coupling circuit.	Check CR4501 and coupling components.
19. Voltage at TP4506 and TP4507 below normal.	Defect in dc amplifier V4502 circuit. Defect in agc bias control relay K4501.	Check V4502 circuit components; check relay windings of K4501.

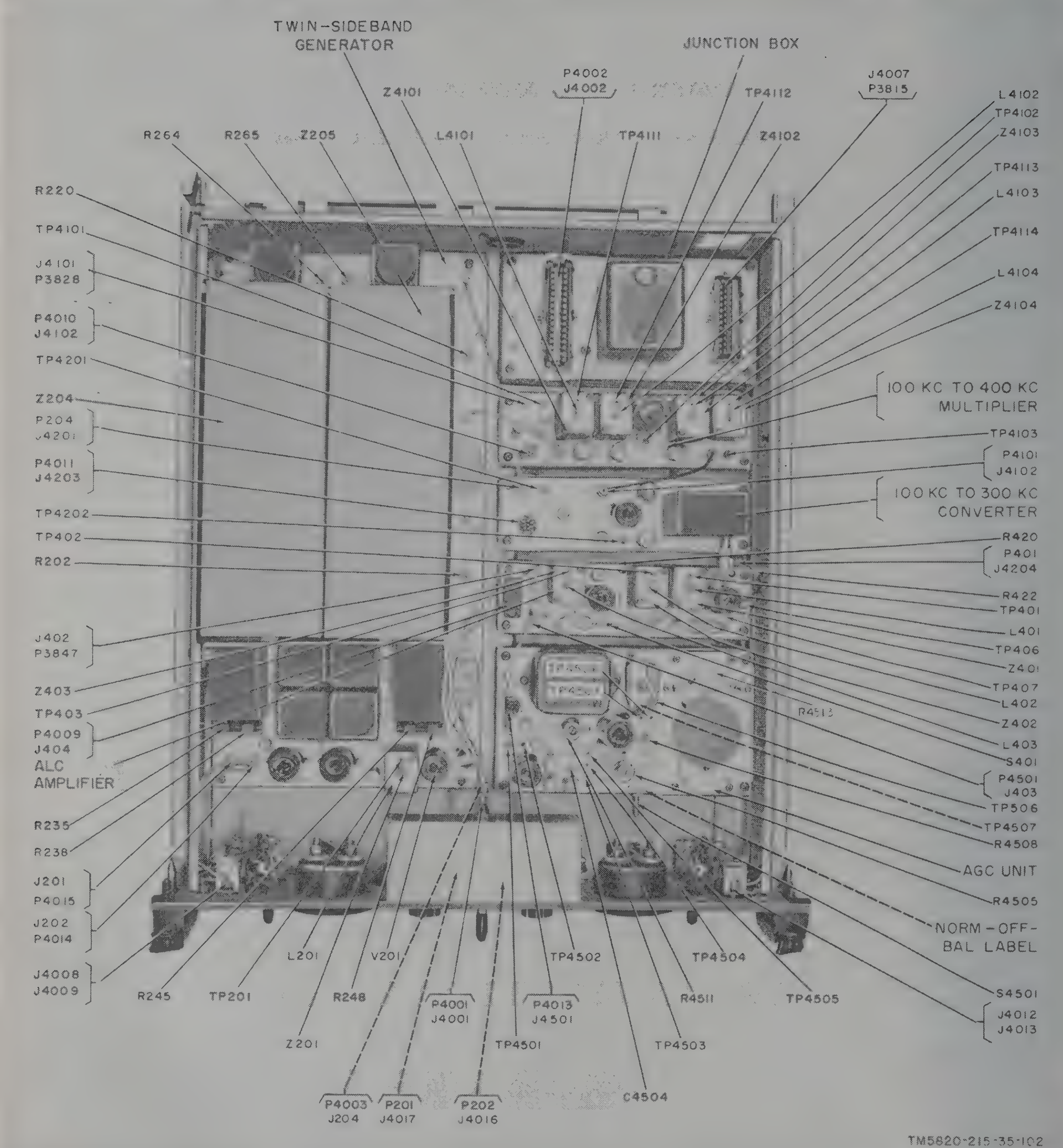


Figure 91. Tsb modulator, top view.

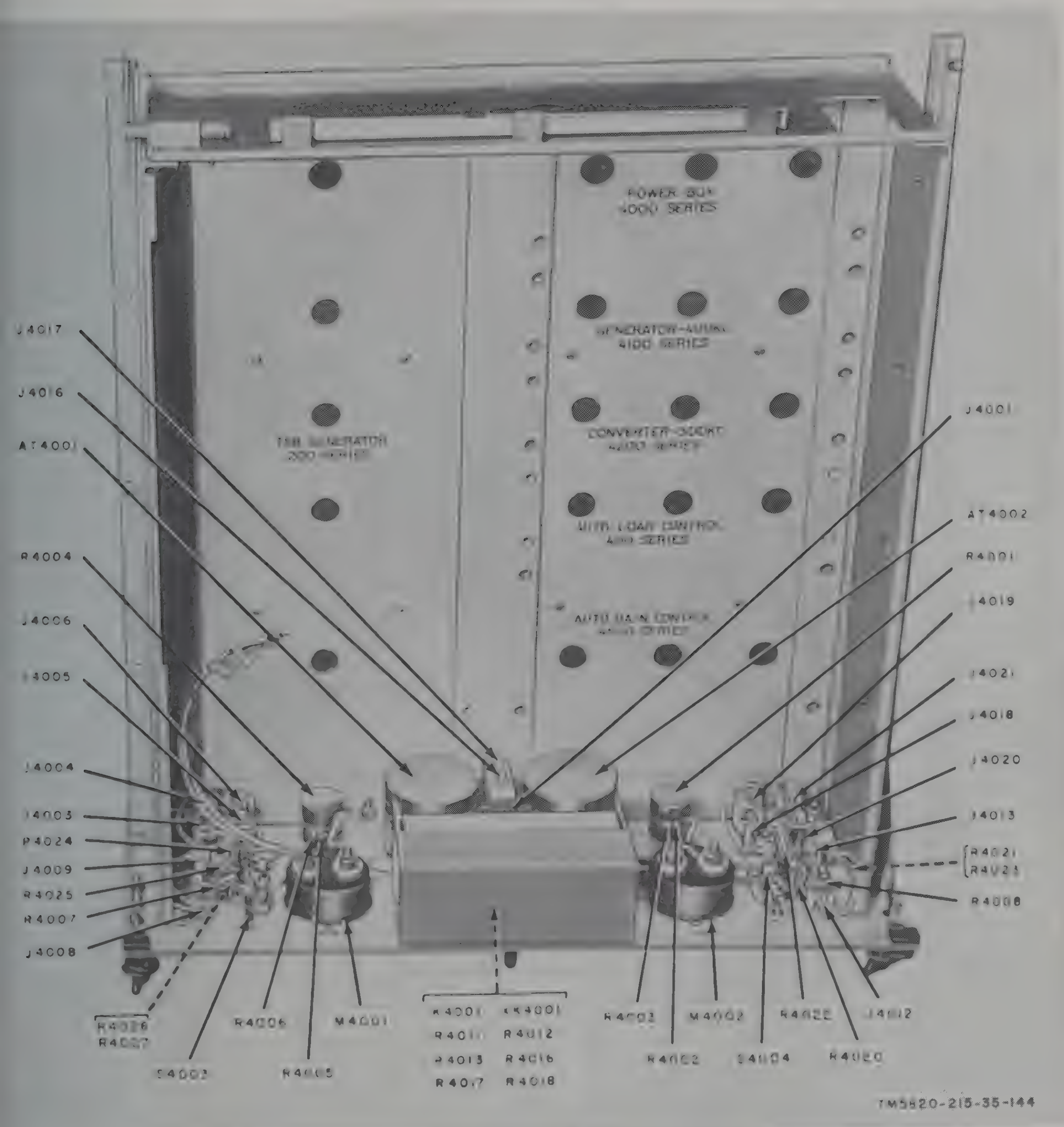


Figure 92. Tsb modulator, front panel, rear view.

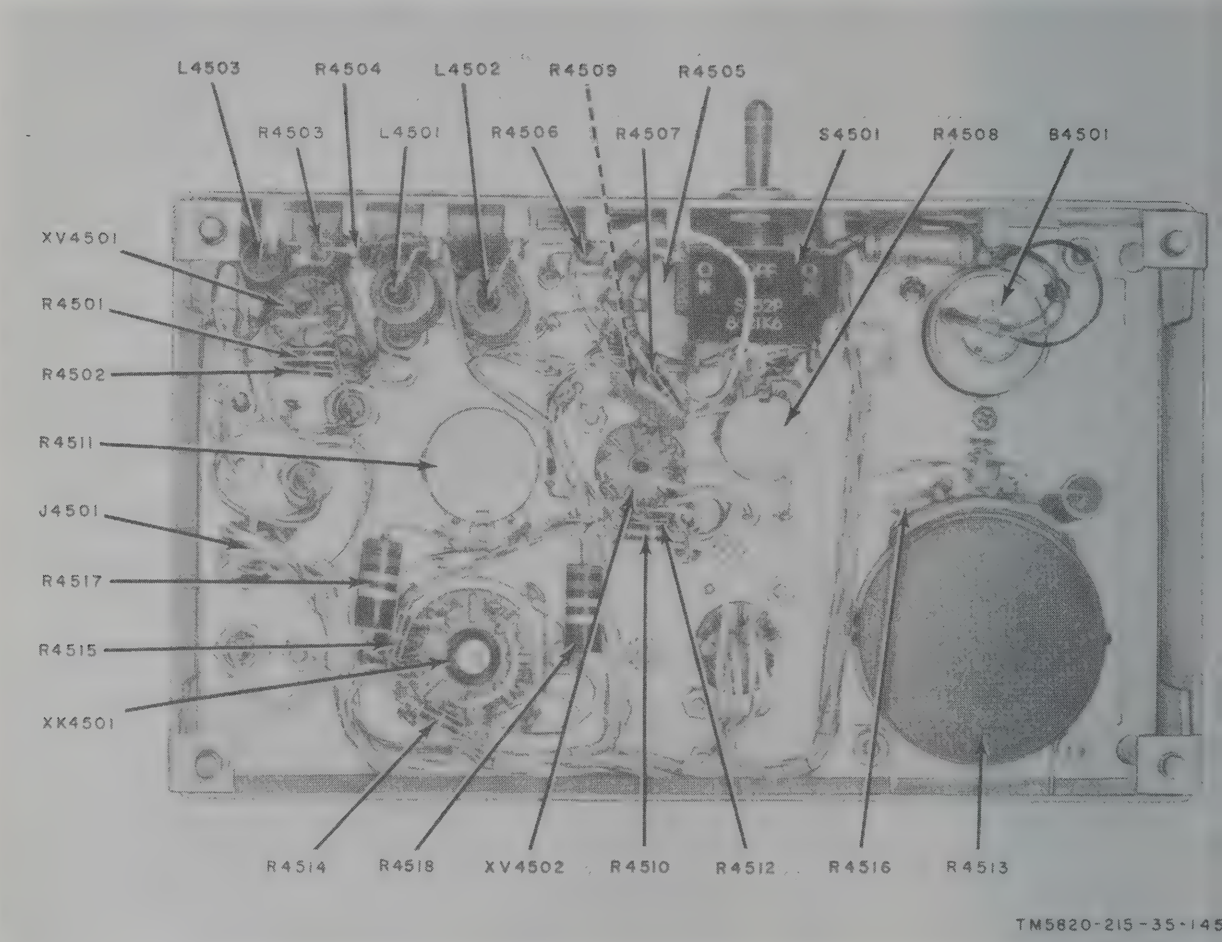


Figure 93. Tsb modulator, agc unit, bottom view showing resistors.

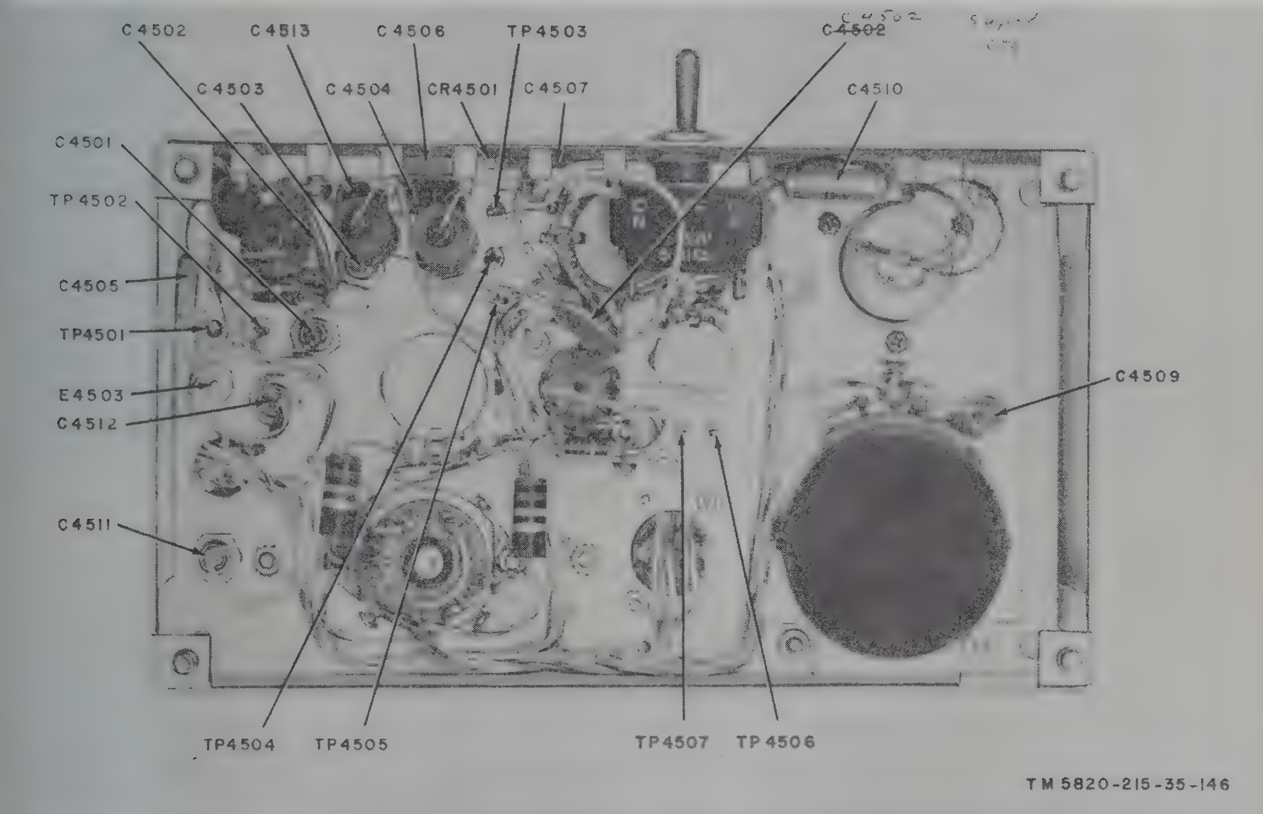


Figure 94. Tsb modulator, agc unit, bottom view showing capacitors.

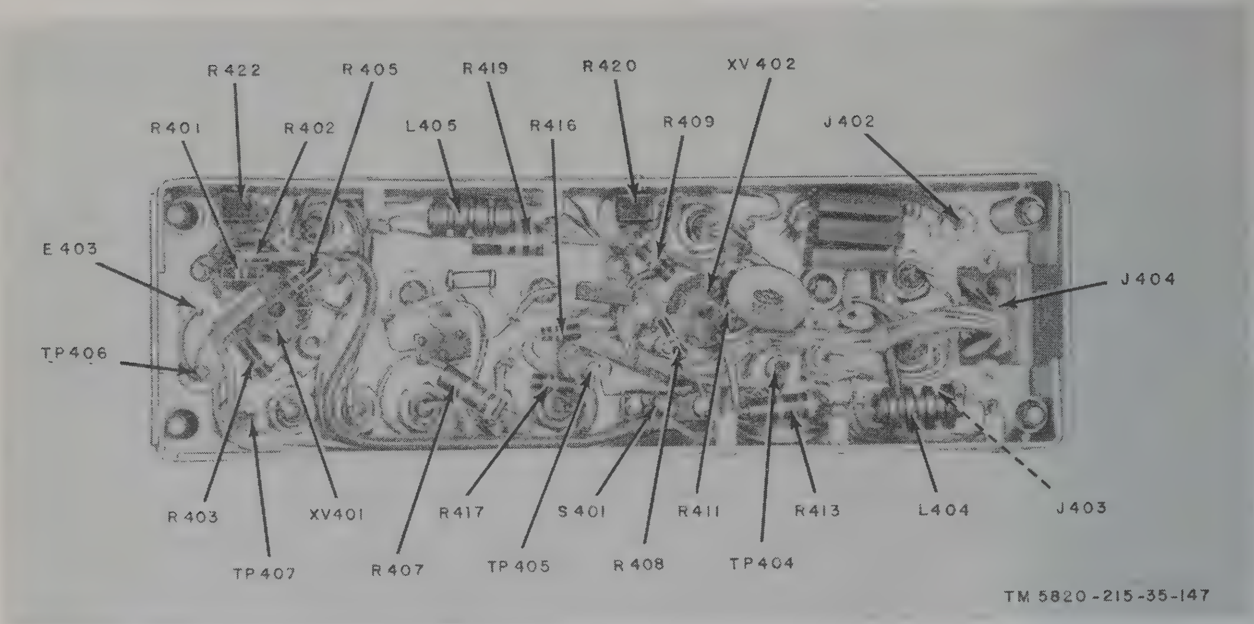


Figure 95. Tsb modulator, alc chassis, bottom view showing resistors.

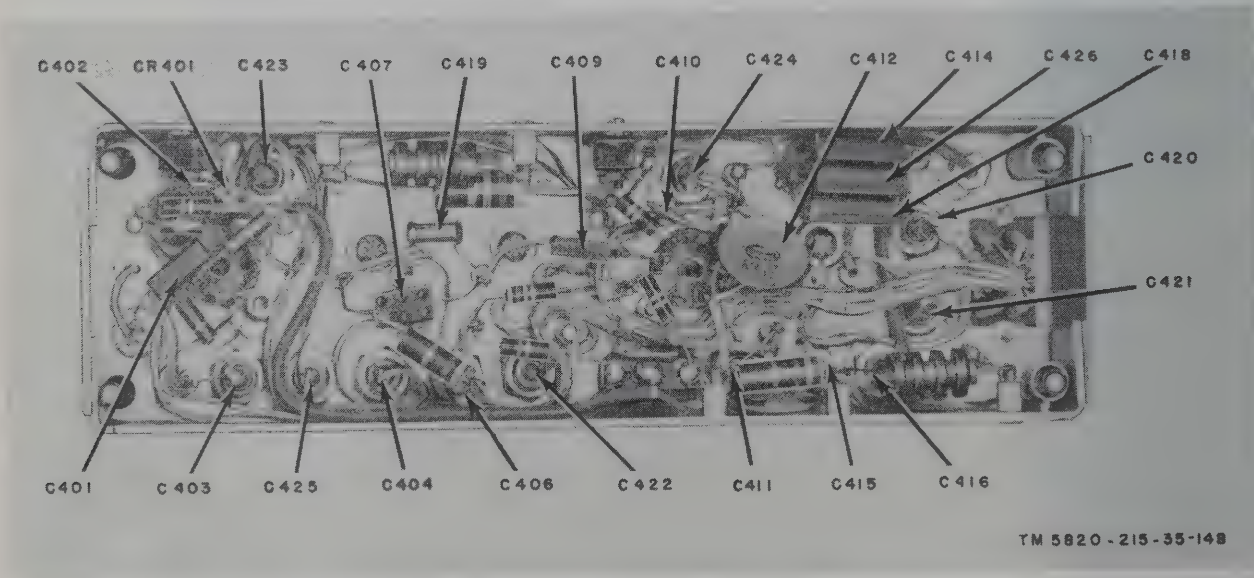


Figure 96. Tsb modulator, alc chassis, bottom view showing capacitors.

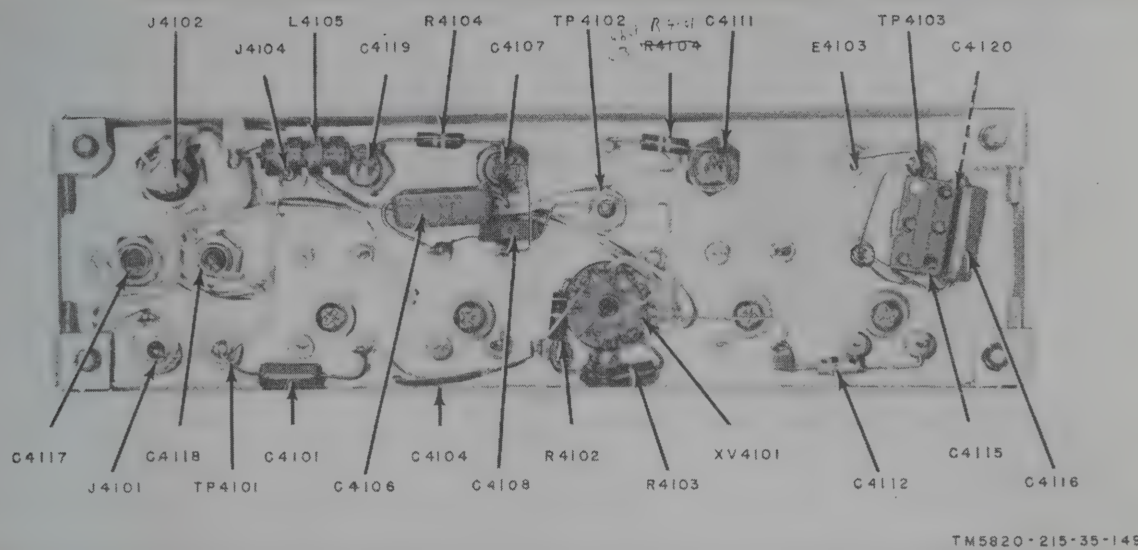


Figure 97. Tsb modulator, 100- to 400-kc multiplier subchassis, bottom view.

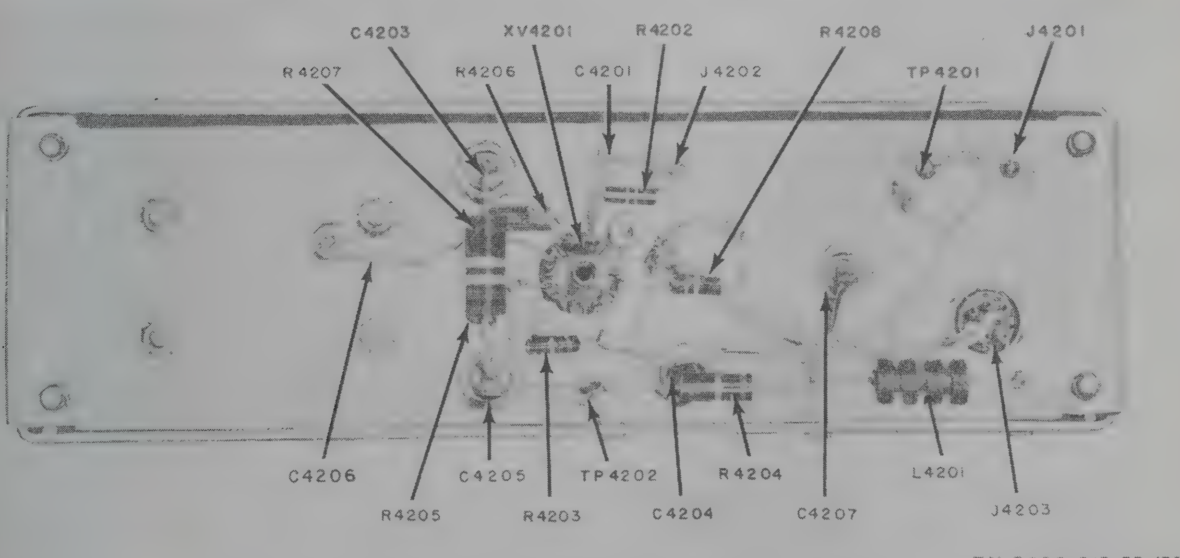


Figure 98. Tsb modulator, 300-kc converter subchassis, bottom view.

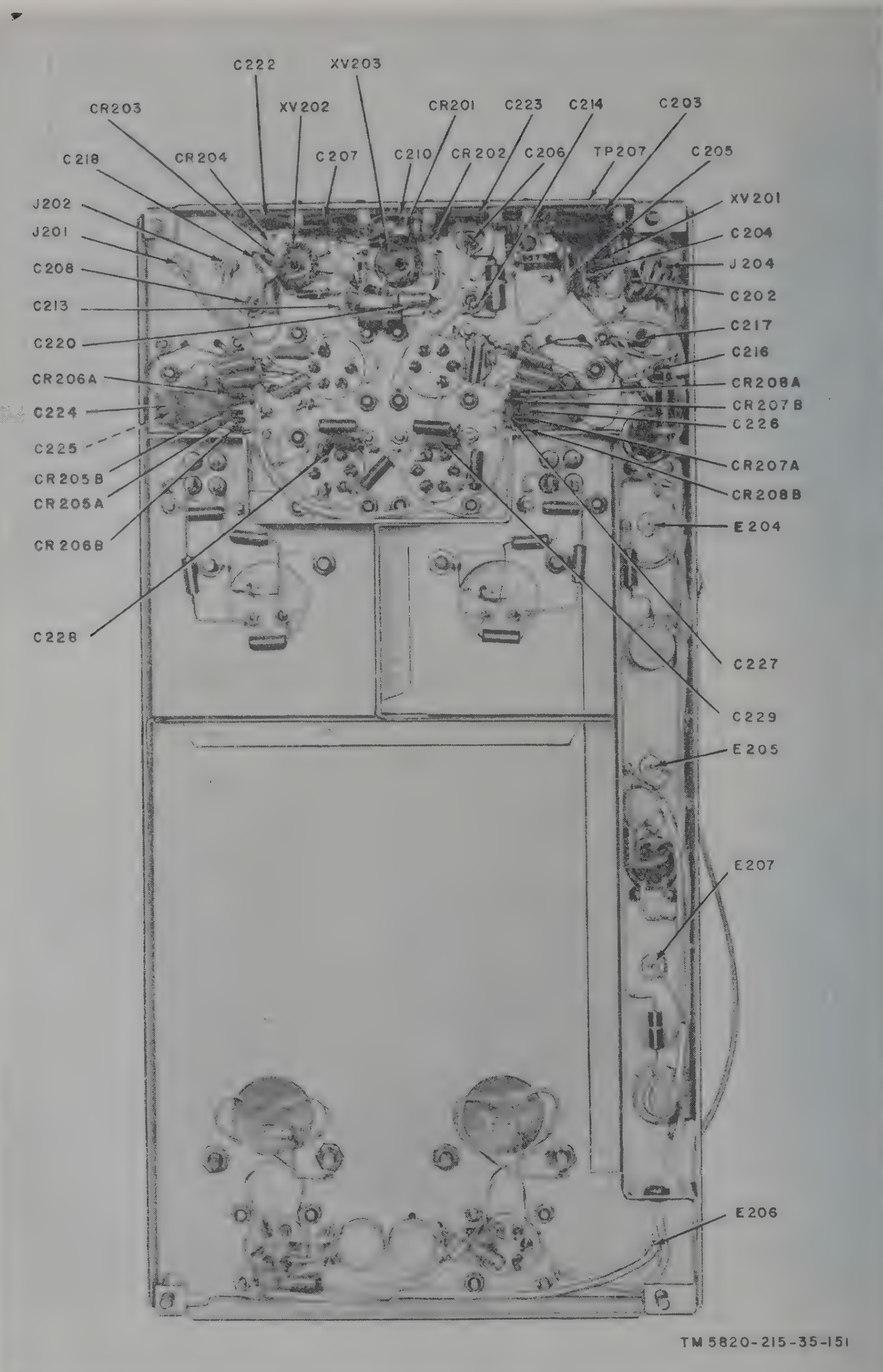


Figure 99. Tsb modulator, sideband generator subchassis, bottom view showing capacitors.

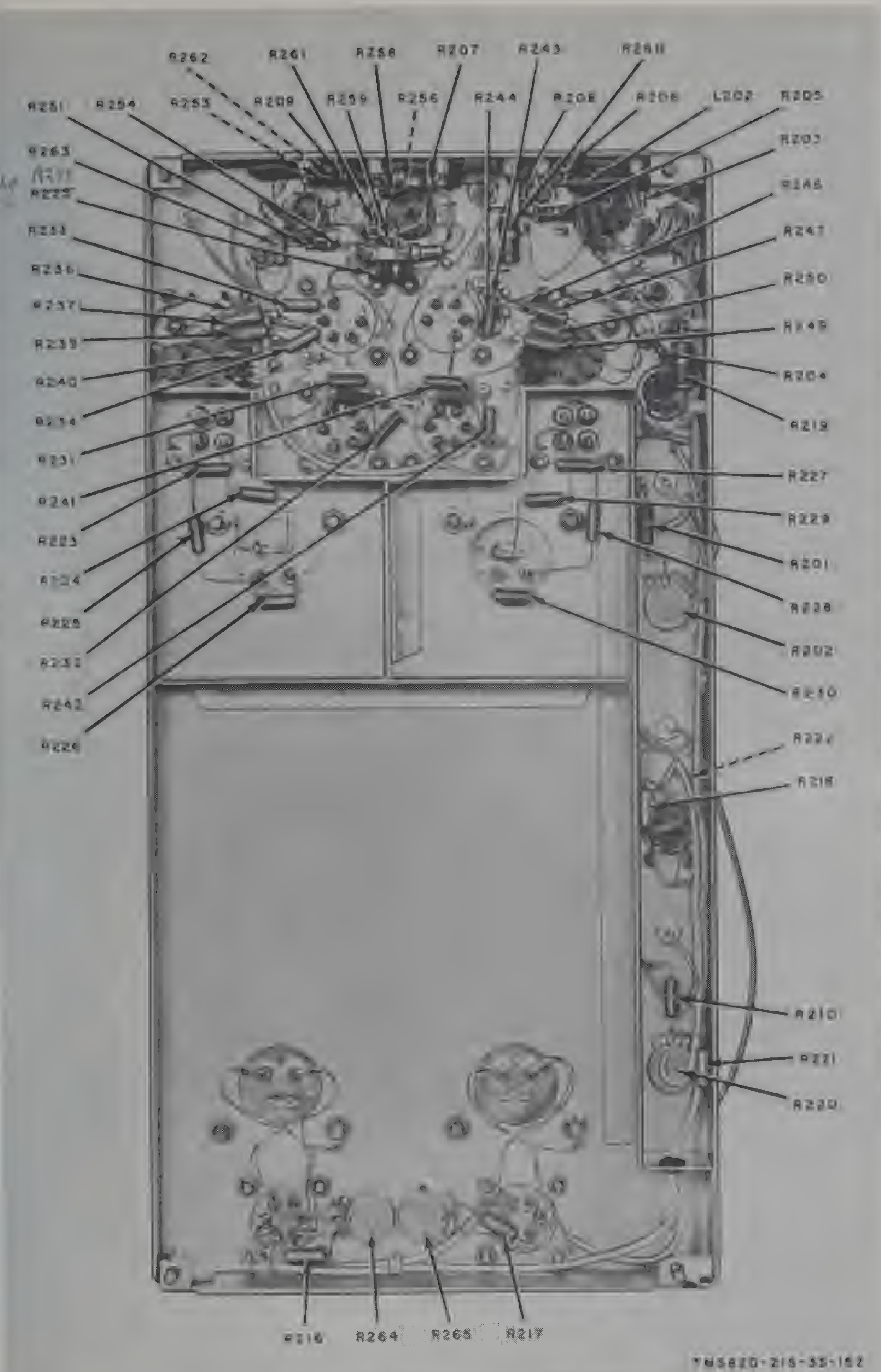


Figure 100. Tsb modulator, sideband generator subchassis, bottom view showing resistors.

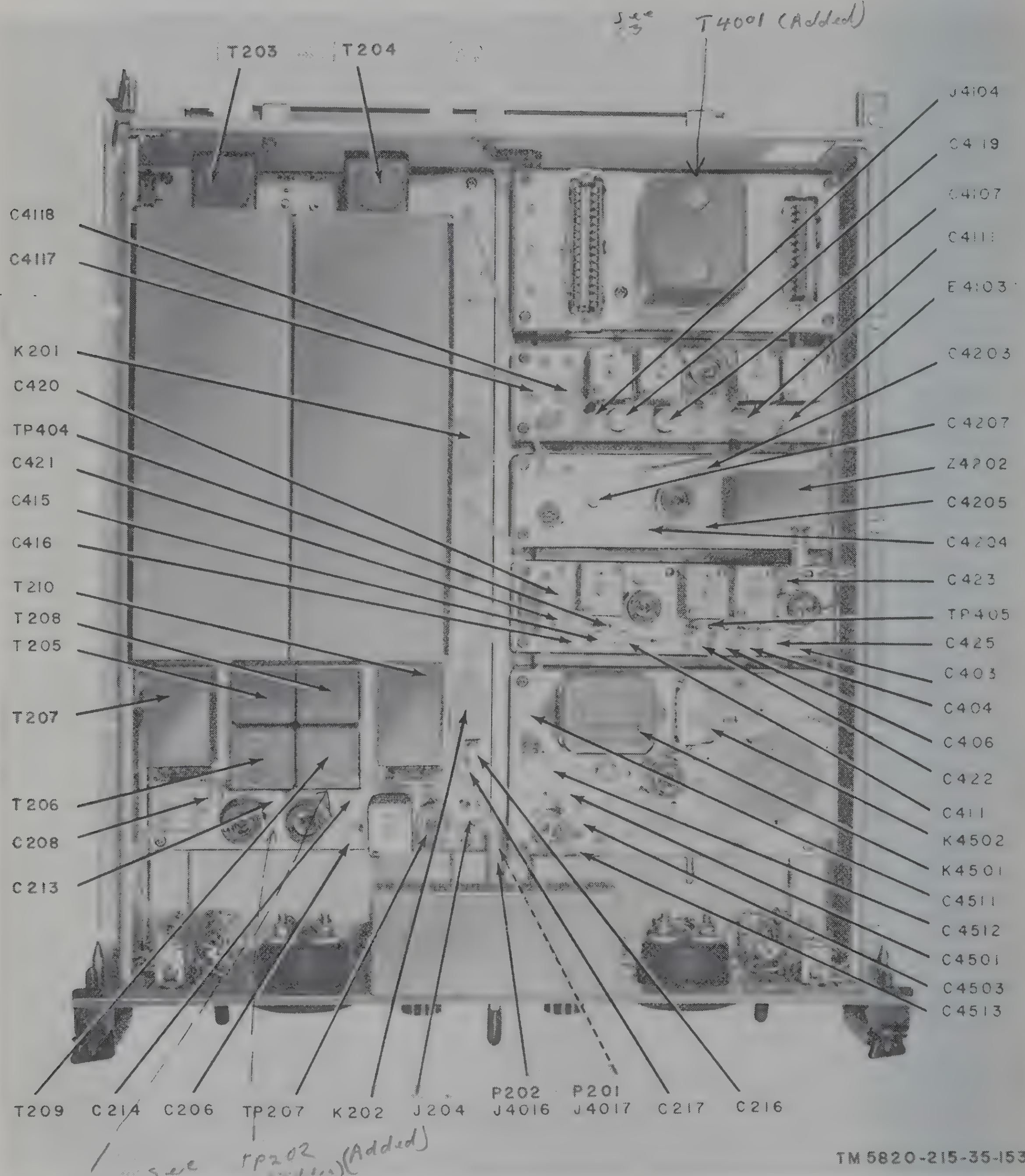


Figure 101. Tsb modulator, sideband generator subchassis, bottom view showing capacitors.

See TP203
C3 (Hidden) (Added)

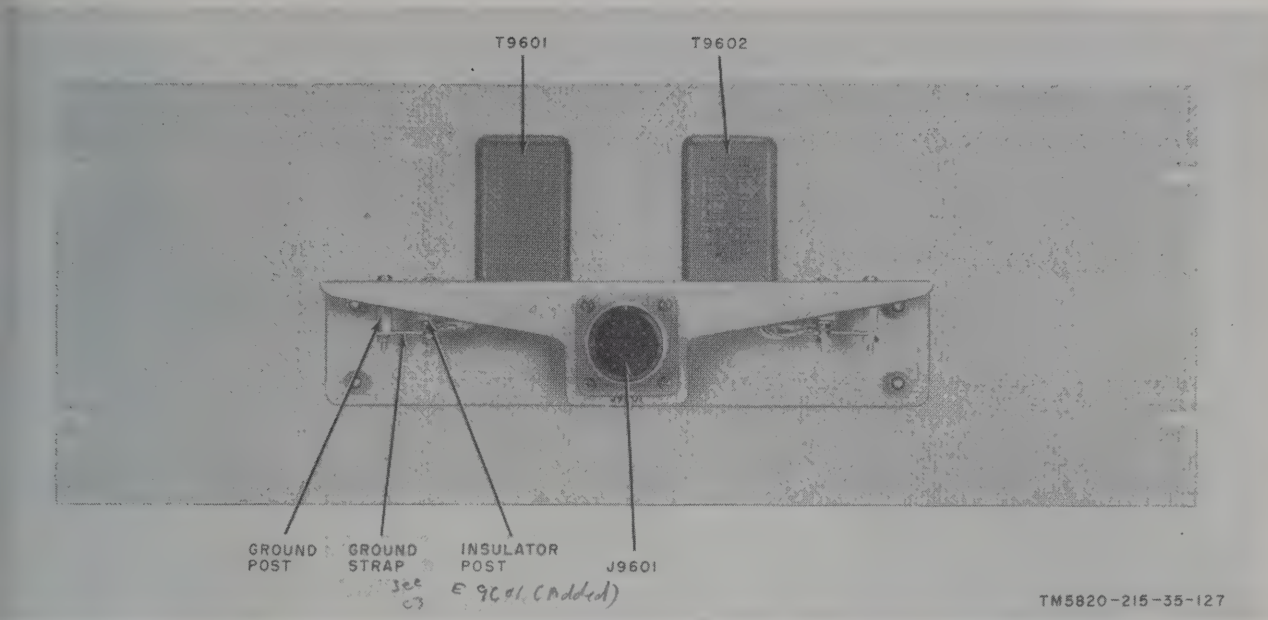


Figure 102. Input transformer panel.

119. Exciter-Monitor Troubleshooting Charts
(figs. 103 through 125 and 151 through 154)

The exciter-monitor compartment consists of several major subchassis. Because of the large number of stages involved, separate troubleshooting charts are presented for each major subchassis. Various test points to be checked are listed in the *Correction* column of the charts. When trouble in the modulator-oscillator group has been sectionalized to the exciter-monitor compartment, refer to steps 39 through 56 of the equipment performance checklist (TM 11–5821–212–20) to isolate the trouble to a particular section of a subchassis within the exciter-monitor. Go directly to the referenced subchassis and perform the appropriate corrective measures.

a. Smo and Smo RF Chassis Troubleshooting Chart (figs. 106, 107, and 152).

Symptom	Probable trouble	Correction
1. Low or no output from stabilized master oscillator at TP1522.	Defect in V1101 or V1102 stages.	Check for proper value of +210v supply voltage, R1102 through R1107 and resistance from all V1101 and V1102 socket terminals to ground. If measurements are correct, replace the entire smo subchassis.
2. Low or no signal voltage at TP1524 with the B/AND switch on any band.	Defect in buffer amplifier V1503.	Check voltages at TP1522 and TP1533. Check voltages at TP1509 and TP1510. Check components in circuit where test point voltage is abnormal.
3. Low or no signal voltage at TP1527 when the band switch is set to band 3 or 4.	Defect in frequency multiplier V1506 or buffer amplifier V1507 stages.	Check voltages at TP1513, TP1537, and TP1516. Check associated circuit components.
4. Low or no signal voltage at TP1528 when the band switch is set to band 5.	Defect in Z1514, Z1515, Z1518, or Z1519.	Check voltages at TP1514, TP1515, TP1518, and TP1519. Check circuit components associated with test point where the measured voltage is abnormal.
5. 100-kc voltage at TP1521 normal but low or no voltage at TP1501.	Defect in 100-kc amplifier V1501.	Check V1501 cathode voltage at TP1531. Check circuit components associated with V1501.

Symptom	Probable trouble	Correction
6. Input voltage (as measured at TP1501) normal but voltage at TP1532 low.	Defect in CR1501, CR1502, or CR1503. Defect in 100-kc spectrum generator V1502.	Check CR1501 through CR1503. Check components associated with V1502.
7. Waveform incorrect or no signal voltage at TP1502 when the band switch is set to band 1 or 2.	Defective Z1502 or switch S1501.	Check Z1502 and S1501 (contacts 1 and 2).
8. Waveform incorrect or no signal voltage at TP1504 when band switch is set to band 3.	Defective Z1503, Z1504, or S1501.	Check signal voltage at TP1503. Check Z1503, Z1504, and switch S1501.
9. Waveform incorrect or no signal voltage at TP1506 when the band switch is set to band 4.	Defect in Z1505, Z1506, or switch S1501.	Check signal voltage at TP1505. Check Z1505, Z1506, and switch S1501.
10. Waveform incorrect or no signal voltage at TP1508 when the band switch is set to band 5.	Defect in Z1507, Z1508, or switch S1501.	Check signal voltage at TP1507. Check Z1507, Z1508, and switch S1501.
11. Inputs to mixer-amplifier V1504 normal but waveform or signal incorrect at TP1511. (To verify input voltages for band 1 or band 2, check signal at TP1502, for band 3 check inputs at TP1504 and TP1524, for band 4 check inputs at TP1506 and TP1516, and for band 5 check inputs at TP1508 and TP1518).	Defective in mixer-amplifier V1504 or Z1511.	Check V1504 cathode voltage at TP1534. Check V1504, Z1511, and associated components.
12. Signal input at TP1512 normal but no signal at TP1535.	Defect in mixer V1505 or circuit components.	Check R1527, R1528. Check components associated with V1505.

b. Smo Error Detector and Interpolation Oscillator Troubleshooting Chart (figs. 119, 120, 124, and 152).

Symptom	Probable trouble	Correction
1. No signal output from interpolation oscillator cathode follower V1002 (check output at TP1703).	Defective component or tube in V1001 or V1002 stages.	Check V1001 and V1002 screen, plate, and control grid resistors for proper value. Check resistance from all V1001 and V1002 socket terminals to ground for proper measurements. If the above checks are normal, replace the interpolation oscillator subchassis.
2. With METER switch set to position 1 (MO CONTROL CURRENT), meter indicates less than 4.8 or more than 5.2 (FREQ-MC and FREQ-KC controls must be locked).	Stabilized master oscillator out of alignment.	Refer to step 1 of *a* above. Aline stabilized master oscillator (para 131*a*).
3. With METER switch set to position 3 (ϕDETECTOR INPUT) meter indicates less than 2.9 or more than 3.1.	No input signal or defect in V1701, V1702, or V1703 circuits.	Check input voltages at TP1702 and TP1703. If inputs are normal, check V1701 cathode voltage at TP1701. Check V1701, V1702, V1703, and associated circuit components.
4. Frequency discriminator CR1702 output below or above 0 ±1 volt at TP1705.	Defect in V1703, Z1704, Z1705, or CR1702.	Check Z1704, Z1705, CR1702, and associated circuit components.

Symptom	Probable trouble	Correction
5. With the 0.5 KC LOCK switch set to ON, the voltage at TP1706 is above or below 0 ±01. volt.	No rf voltage to V1705 from 0.5-kc spectrum detent. Defect in phase detector CR1708 or V1705 stage.	Check for rf voltage to V1705 by comparing voltage at grid of V1705 with that measured at TP1206. The two voltages should have the same waveform and approximately the same voltage level. If the input is normal, check V1705, CR1708, and associated circuit components.
6. Input to smo control amplifier V1706 normal (checked at TP1706), smo error not corrected.	Defect in stabilized master oscillator. Defect in V1706 stage.	Check V1706 and associated circuit components. If measurements are normal, refer to step 1 of *a* above.
7. Output voltage of CR1703 (check at TP4804) below 3.8 volts.	Defect in buffer amplifier V1704A or CR1703 stage.	Check V1704A, CR1703, and associated circuit components.
8. Output voltage of CR1707 below 9 volts (checked at TP4805).	Defect in buffer amplifier V1704B or CR1707 stage.	Check V1704B, CR1707, and associated circuit components.

c. Phase Lock Indicator and 0.5-Kc Spectrum Detent Troubleshooting Chart (figs. 117, 118, and 152).

Symptom	Probable trouble	Correction
1. Control amplifier cathode voltage (at TP4801) below +1.5 volts.	Defect in control amplifier V4801, input voltage missing.	Check V4801 and associated circuit components.
2. Voltages at TP4803 below +1.5 volts.	Defect in CR4801, CR4802 or coupling capacitor C4801.	Check CR4801, CR4802, C4801, and associated circuit components.
3. Relay control discriminator V4802 does not actuate relay K4801.	Incorrect input voltages. Defect in V4802 circuit. Defective relay K4801.	Check inputs at TP4803, TP4804, and TP4805. Check V4802 and associated circuit components. Check coil and contacts of K4801.
4. No output from 0.5-kc spectrum detent when 0.5 KC LOCK placed in ON position.	Defective relay K1203.	Check waveform at TP1206. If waveform is normal, replace relay K1203. If no waveform at TP1206, proceed to step 5.
5. Waveform or voltage at TP1201 not as listed.	No 1-kc input from 1-kc generator in frequency standard compartment. Defect in clipper CR1201 or CR1202. Defect in V1201 or V1202.	Check for 1-kc signal at control grid (pin 1) of V1201. Check CR1201, CR1202, V1201, V1202, and associated circuit associated circuit components.
6. Incorrect waveform or voltage at TP1206.	Defective component between mixer V1203 and V1206.	Check cathode voltage of V1203 through V1206 by measuring voltages at TP1203, TP1204, TP1205, and TP1207. Check circuit components at the first stage where the cathode voltage is not as listed in paragraph 120*d*0.
7. No output from the 0.5-kc spectrum detent when 0.5 KC LOCK placed in the OFF position.	Defective relay K1203 or no 250-kc input from frequency standard compartment.	Check relay K1203. Check for 250-kc input from the frequency standard at terminal 7 of K1203.

d. Mixer-Amplifier Troubleshooting Chart (figs. 111 through 115 and 151). Troubleshooting the mixer-amplifier is facilitated by the use of the various test points located in each stage. When the *Correction* column lists test points to be checked, measurements should be made in the order that the test points are listed. The first abnormal reading will be an indication that the fault is in the stage associated with the test point being measured. Check the circuit components associated with the test point where the reading is abnormal.

Symptom	Probable trouble	Correction
1. No output from exciter-monitor compartment on any band.	No input signal (or signals) to mixer-amplifier stages. Defect in power supply.	Check for 300-kc tsb input at TP801. If no 300-kc signal is present, refer to tsb modulator troubleshooting chart. Check for 2-4-mc input from smo rf chassis at J825. If no 2-4-mc signal present, refer to smo-rf troubleshooting chart. If both signals are normal, refer to the power supply troubleshooting chart and check the +210-volt and +300-volt exciter-monitor supplies.
2. No output when equipment is operated on band 1 or band 3. Output on band 2, 4, or 5 normal.	Defective component in band 1 mixer-amplifier stage.	Check signal voltage at band 1 output TP1807. If output is normal, check coupling and switch S4406. If no output is present at TP1807, check signal at TP1801, TP1802, TP1812, TP1803, TP1804, TP1813, TP1805, TP1806, and TP1814 in that order.
3. No output when equipment is operated on band 2, 4, or 5. Output on band 1 or 2 is normal.	Defective component in band 2 mixer-amplifier stage.	Check signal voltage at band 2 output TP1907. If output is normal, check jack and plug couplings and switch S4406. If no output is present at TP1907, check voltage at TP1901, TP1902, TP1912, TP1903, TP1904, TP1913, TP1906, and TP1914 in that order.
4. No output when equipment is operated on band 3. Output on all other bands is normal.	Defective component in band 3 mixer-amplifier stage.	Check signal voltage at band 3 output TP2005. If output is normal, check jack and plug coupling and switch S4406. If no output is present at TP2005, check voltage at TP2001, TP2002, TP2012, TP2003, TP2004, and TP2013 in that order.
5. No output when equipment is operated on band 4. Output on all other bands is normal.	Defective component in band 4 mixer-amplifier stage.	Check signal voltage at band 4 output TP2105. If output is normal, check jack and plug coupling and switch S4406. If no output is present at TP2105, check voltage at TP2101, TP2102, TP2112, TP2103, TP2104, and TP2113 in that order.
6. No output when equipment is operated on band 5. Output on all other bands is normal.	Defective component in band 5 mixer-amplifier stage.	Check signal voltage at band 5 output TP2205. If output is normal check jack and plug coupling and switch S4406. If no output is present at TP2205, check voltage at TP2201, TP2202, TP2212, TP2203, TP2204, and TP2213 in that order.

e. Monitor Troubleshooting Chart (figs. 121, 122, and 153). Before attempting to troubleshoot the monitor chassis on the basis of a lack of meter indication for a particular setting of the MONITOR INPUT switch, verify that a signal is being applied to the input of first mixer amplifier V1401 by checking for a signal voltage at P1402. If a signal is present at this point, then a defect does exist in the monitor. If no signal exists at this point, check switch S1401 and the source of the signal voltage that is to be metered. When trouble is sectionalized to the monitor, follow the procedure listed below.

Symptom	Probable trouble	Correction
1. With the METER SWITCH in MONITOR SIGNAL LEVEL, no meter indication on any position of the MONITOR INPUT switch.	Defective input switch. No power applied to monitor.	Check switch S1401. Refer to paragraph 115 and check power supply. If these check normal, processed to step 5.
2. Monitor operates only on some positions of MONITOR INPUT switch.	Component in input attenuation network defective. Open contact on S1401.	Check individual signal attenuator networks associated with positions of S1401 that do not produce a meter indication. Check contacts of S1401.
3. Monitor provides an audio indication at P802 but no indication on meter.	Defect in V1404, V1406A, or rectifier CR1401.	Check cathode voltage of V1404 and V1406A at TP1404 and TP1407. Check components in stage with abnormal test point indication. Check CR1401 and associated circuit components.
4. Monitor provides a meter indication but no audio at P802.	Defective demodulator V1405 or audio amplifier V1406B.	Check for audio at terminals 31 and 32 of P802. If no audio exists at these terminals, check cathode voltages of V1405 and V1406B at TP1405 and TP1406. Check associated circuit components.
5. No audio output or meter indication on any position of MONITOR INPUT switch.	Defect in V1401, V1402, or V1403 circuits.	Check cathode voltage at V1401, V1402, and V1403 at TP1401, TP1402, and TP1403. Check associated circuit components.

f. Automatic Tuning System Troubleshooting Chart (figs. 108 and 153).

(1) The most common cause of trouble with the automatic tuning system is incorrect positioning of the BAND, FREQ-MC, or FREQ-KC dials. This is usually caused by failure to lock the wingnuts for the FREQ-MC, FREQ-KC, and BAND controls after a channel is preset manually. *Operating the automatic tuning system with the locking wingnuts loose will cause loss of channel settings on the exciter-monitor and may throw the automatic system out of synchronization.* If incorrect positioning is noted, perform the following:

(*a*) Unlock the three wingnuts on the BAND, FREQ-MC, and FREQ-KC controls.

(*b*) Tune manually to the home stops (low end of tuning range) on the three controls.

(*c*) Reverse tuning, and tune controls to high end of tuning range.

(*d*) Preset two or three channel frequencies.

(*e*) Attempt automatic tuning.

(*f*) If system does tune automatically to desired frequency, refer to paragraph 128 for complete synchronization procedure.

(2) For other troubles with the automatic tuning system, refer to the chart below:

Symptom	Probable trouble	Correction
1. Exciter-monitor frequency may be set manually but will not tune automatically. Automatic tuning motor B801 does not run.	No +28-volt supply applied to automatic tuning motor B801. Defective armature or field winding on B801. No ground return for motor run relay through control head seeking switch and channel selector switch S802.	Check for +28 volts at terminal 1 of motor run relay K802. Check armature and field windings of motor B801. Replace B801 if either winding is open. Check for a ground return path from terminal 10 of K802. If reading is infinite, a defect exists in the control head seeking switch or channel selector switch S802.
2. Motor B801 runs but channel or frequency selections are incorrect.	Automatic tuning system out of synchronization.	Refer to paragraph 128.

Symptom	Probable trouble	Correction
3. Motor B801 runs until all variable tuning slugs controlled by the automatic tuning system are run to their home stops (low end of tuning range). Motor does not reverse to perform the seeking function.	Defective motor reverse relay K801. Defective home reversing limit switch.	Check K801. Check home reversing limit switch.
4. Automatic tuning system performs only the BAND and FREQ-MC tuning functions.	Defective frequency-kc positioning head or shaft coupling.	Check shaft coupling. Replace frequency-kc positioning head.
5. Automatic tuning system performs only the BAND and FREQ-KC tuning functions.	Defective frequency-mc positioning head or shaft coupling.	Check shaft coupling. Replace frequency-MC positioning head.
6. Automatic tuning system performs only the FREQ-MC and FREQ-KC tuning functions.	Defective BAND positioning head or coupling.	Check shaft coupling. Replace BAND positioning head.
7. Motor does not stop after tuning function is completed.	Defective shut off limit switch.	Replace shut off limit switch.

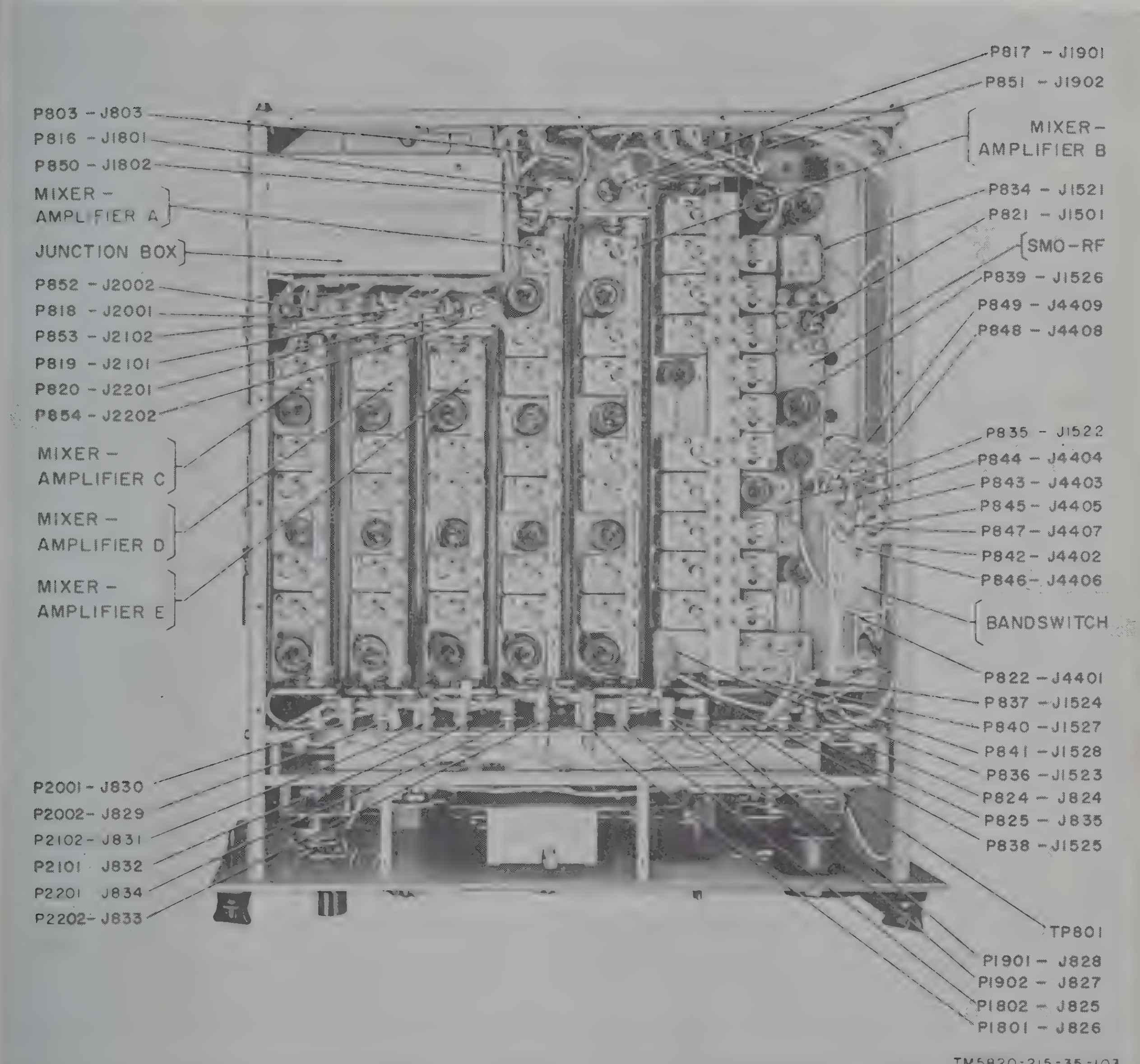


Figure 103. Exciter-monitor, location of subchassis, plugs, and jacks, top view.

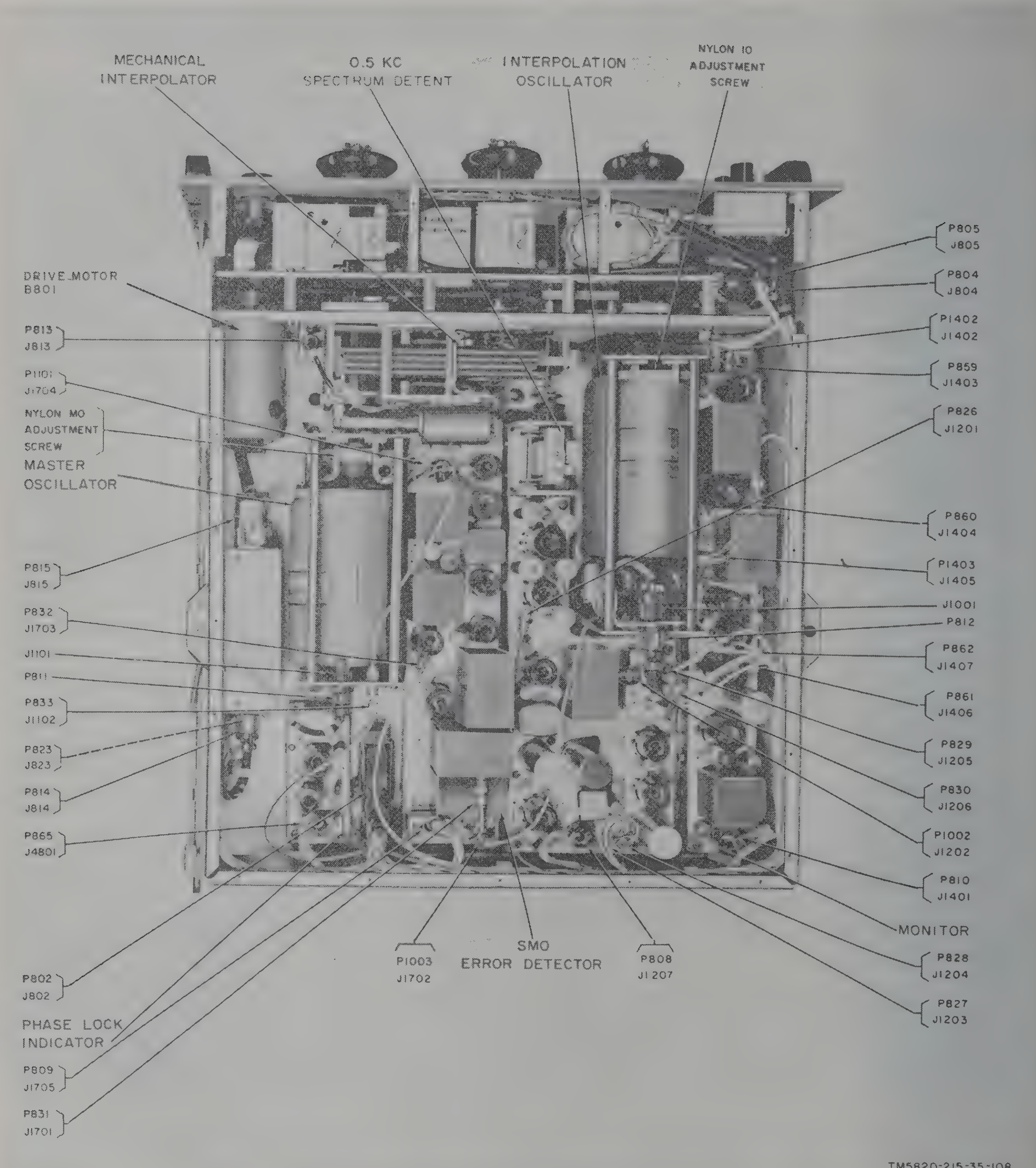


Figure 104. Exciter-monitor, location of subchassis, plugs, and jacks, bottom view.

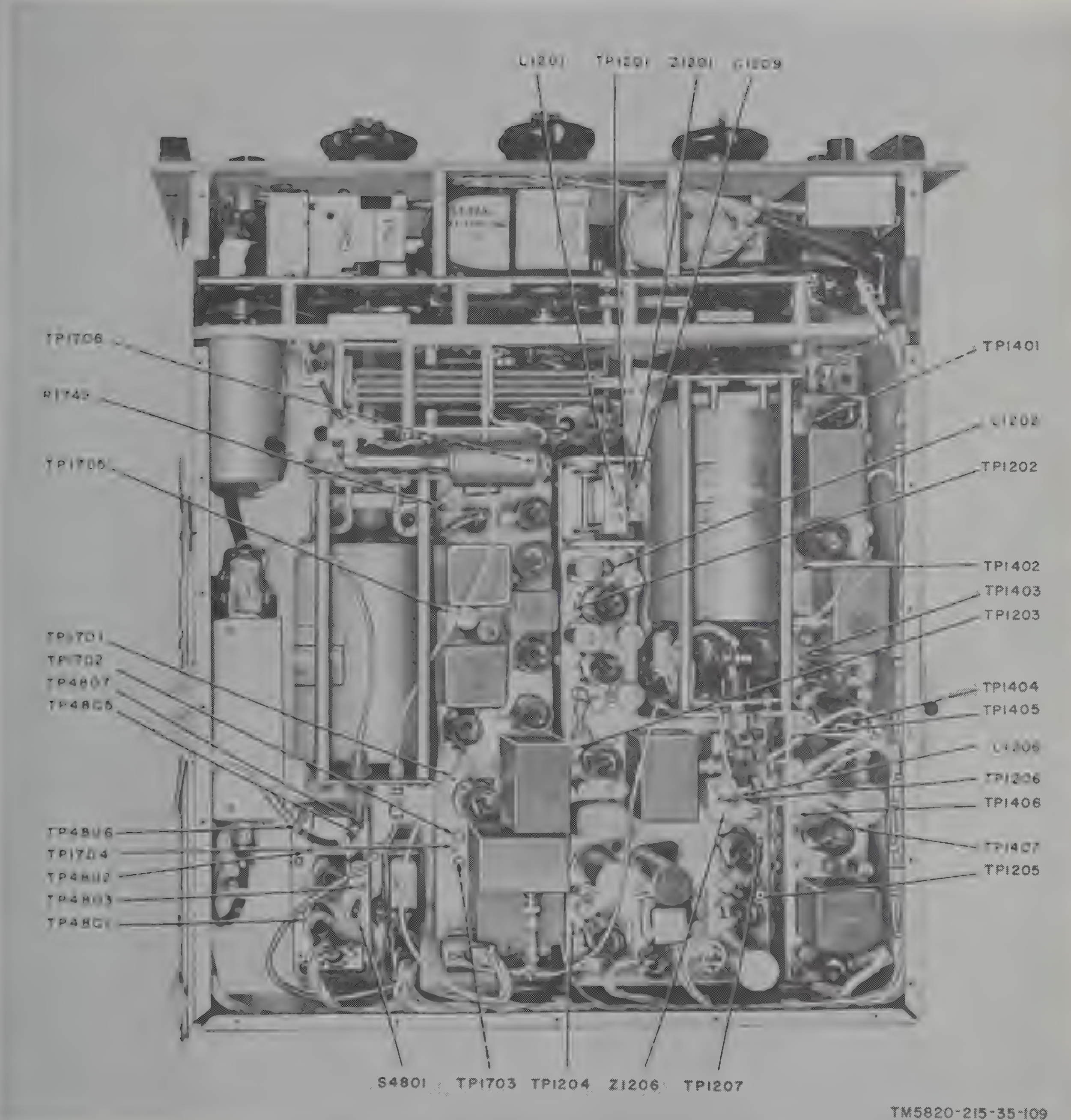


Figure 105. Exciter-monitor, location of test points, bottom view.

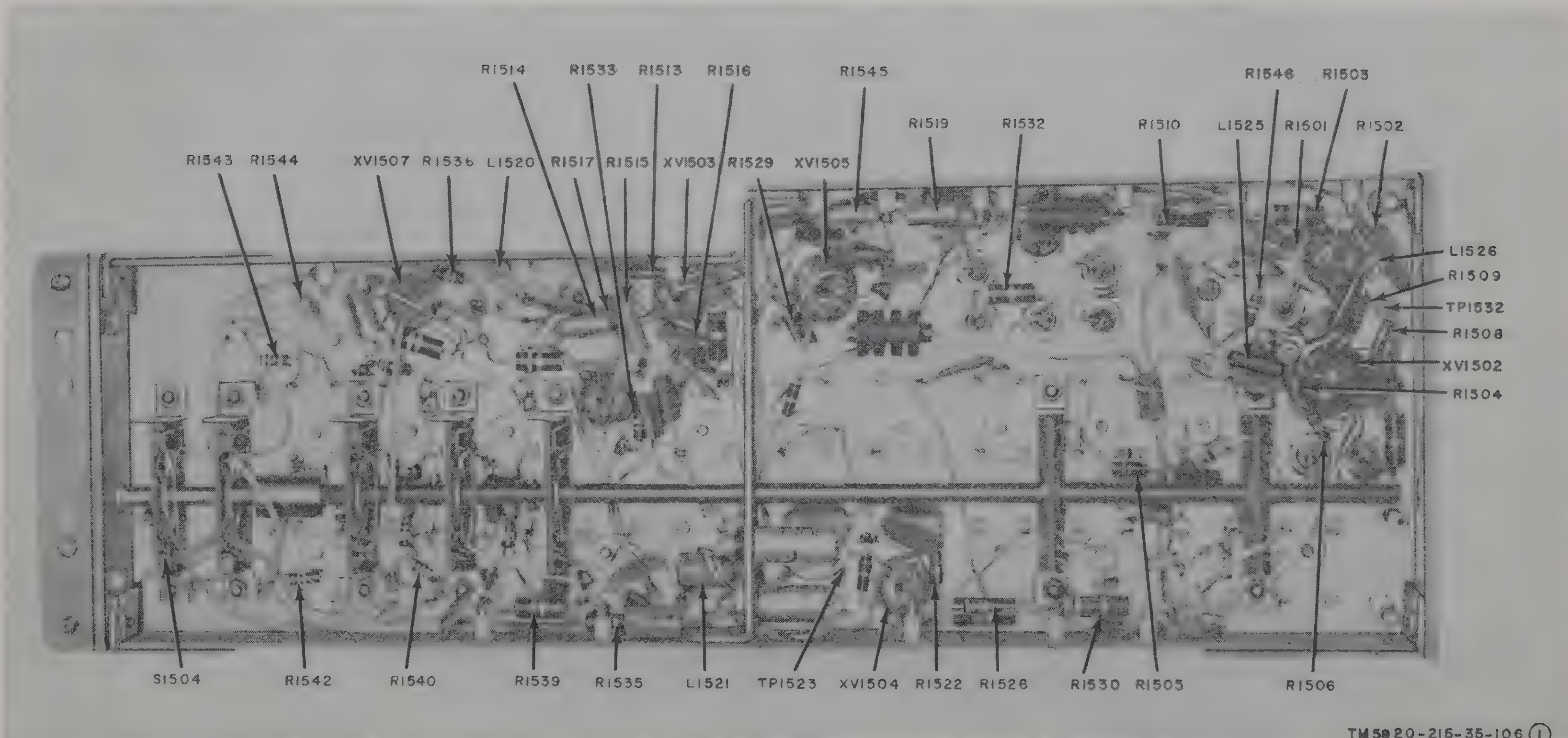


Figure 106. Exciter-monitor, smo RF subchassis, bottom view showing location of resistors (Part 1 of 2).

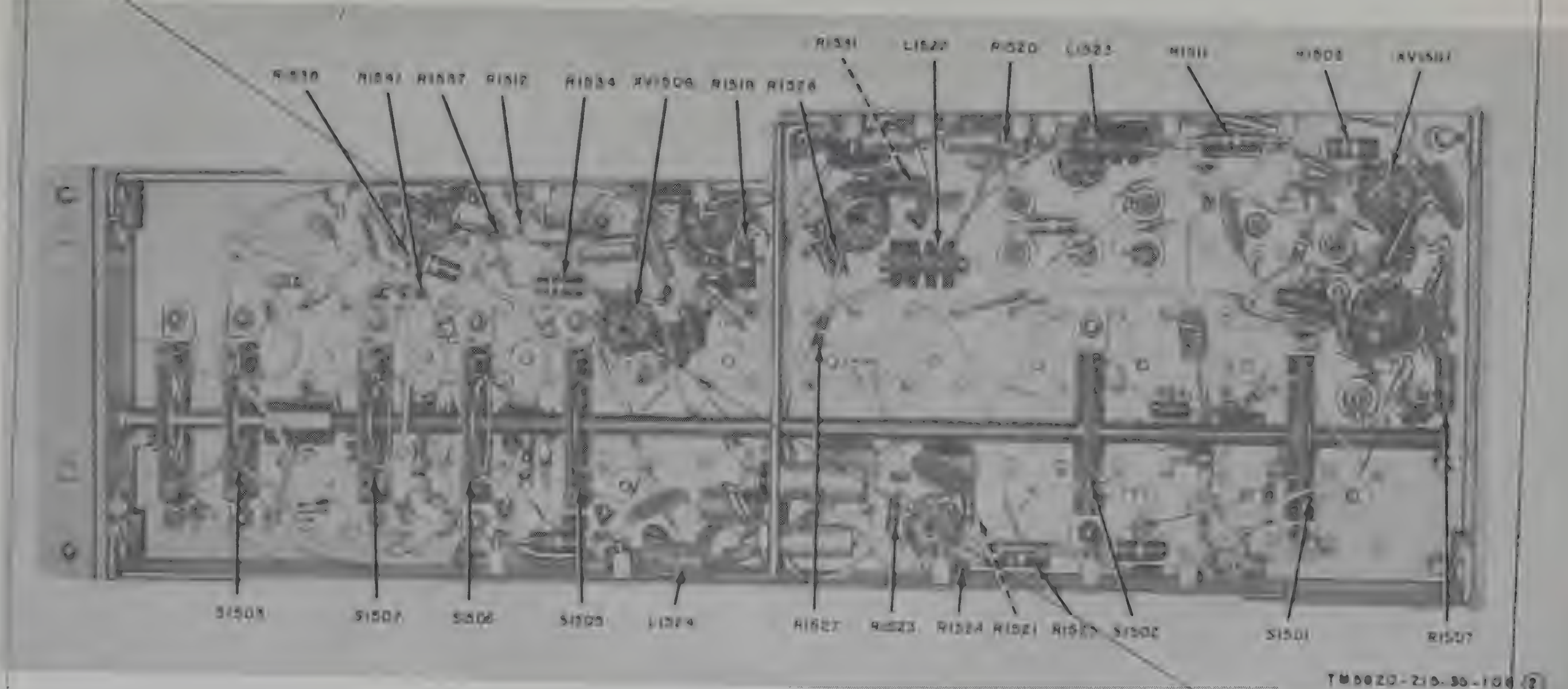


Figure 106—Continued (Part 2 of 2).

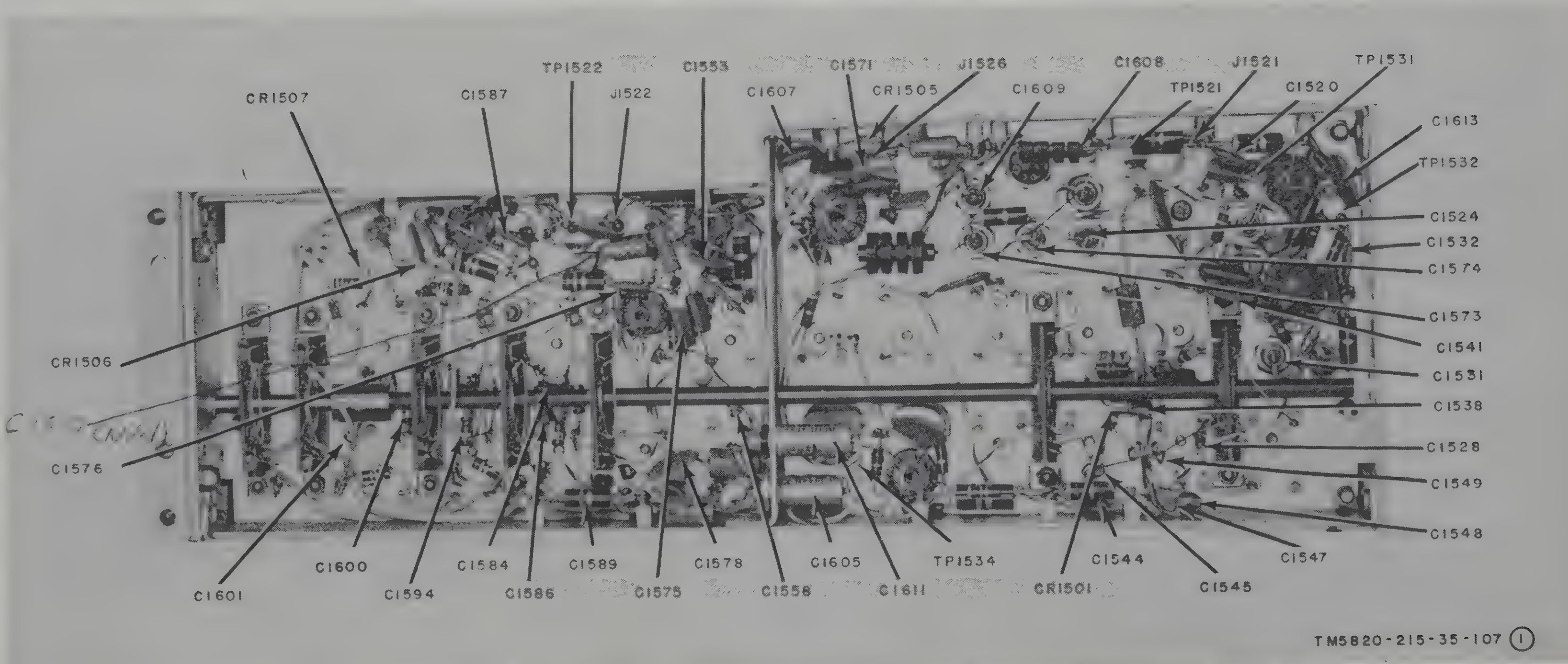


Figure 107. Exciter-monitor, smo RF subchassis, bottom view showing location of capacitors (Part 1 of 2).

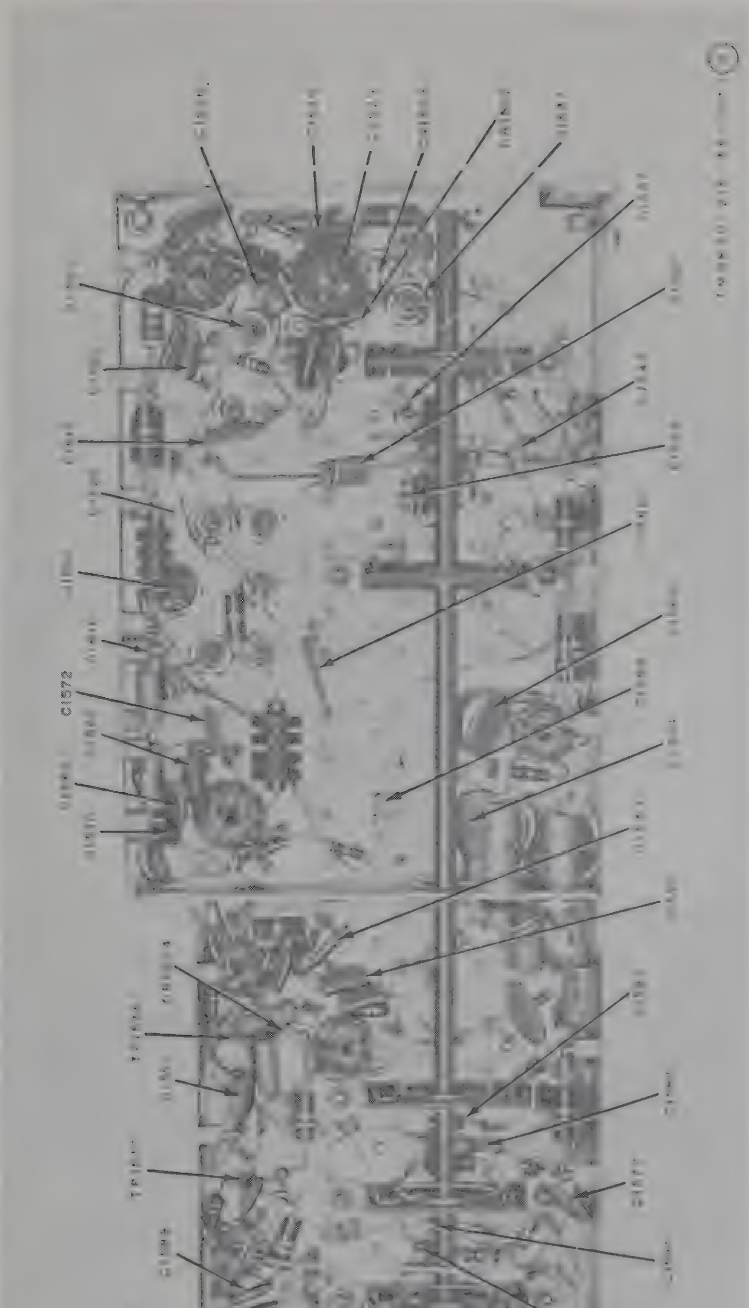


Figure 107—Continued (*Part 2 of 2*).

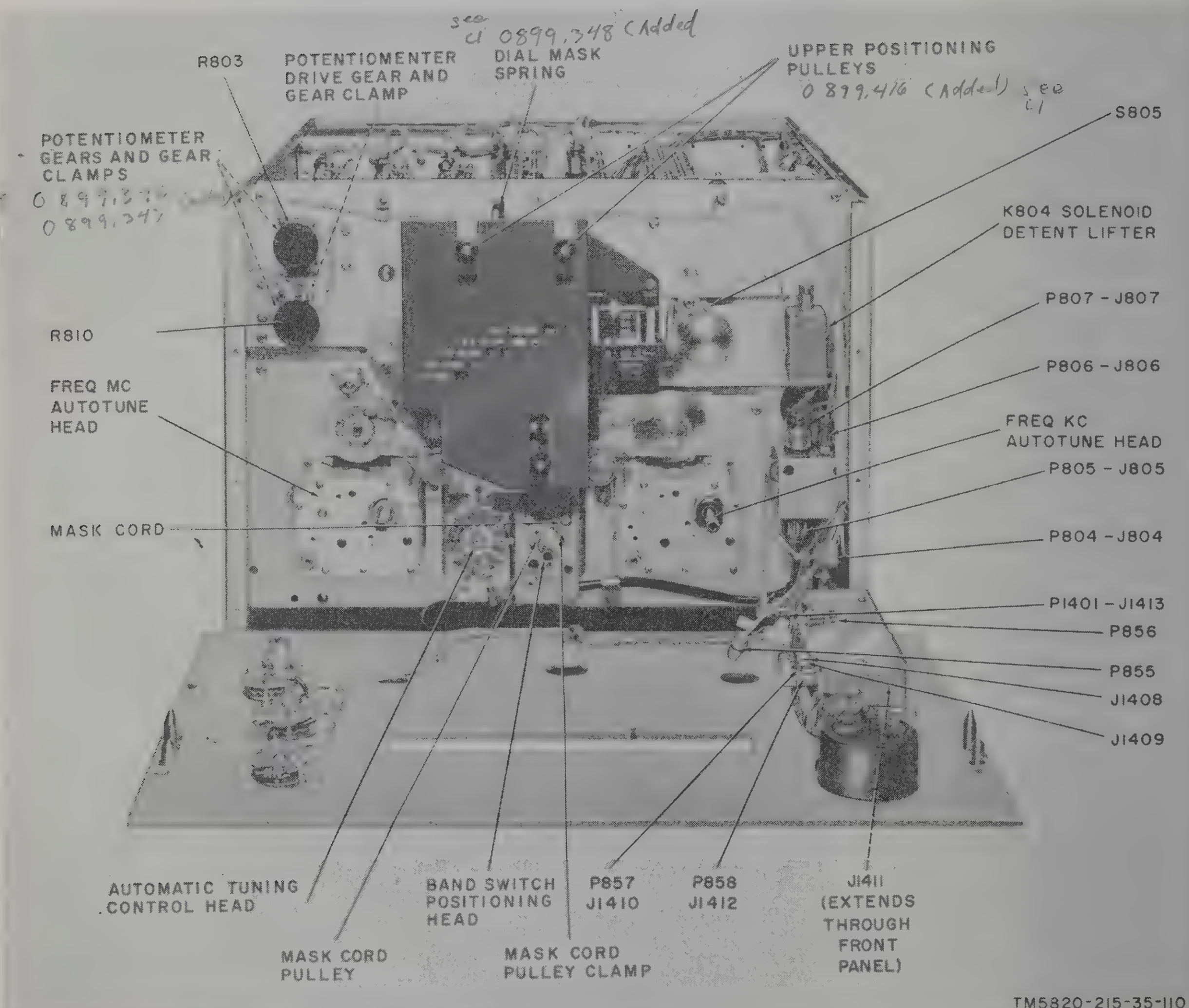


Figure 108. Exciter-monitor, front panel removed, location of plugs, jacks, and control components, front view.

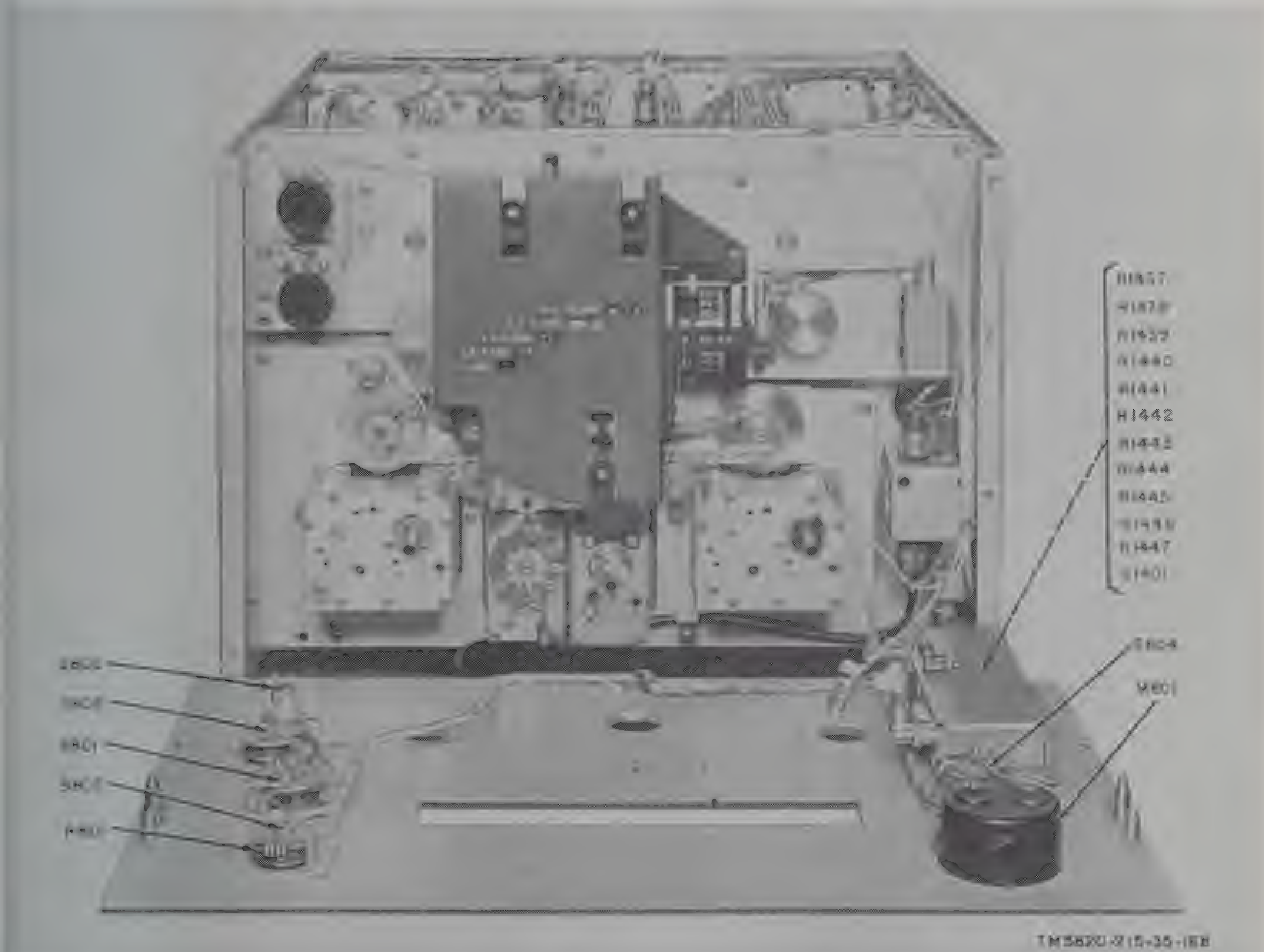
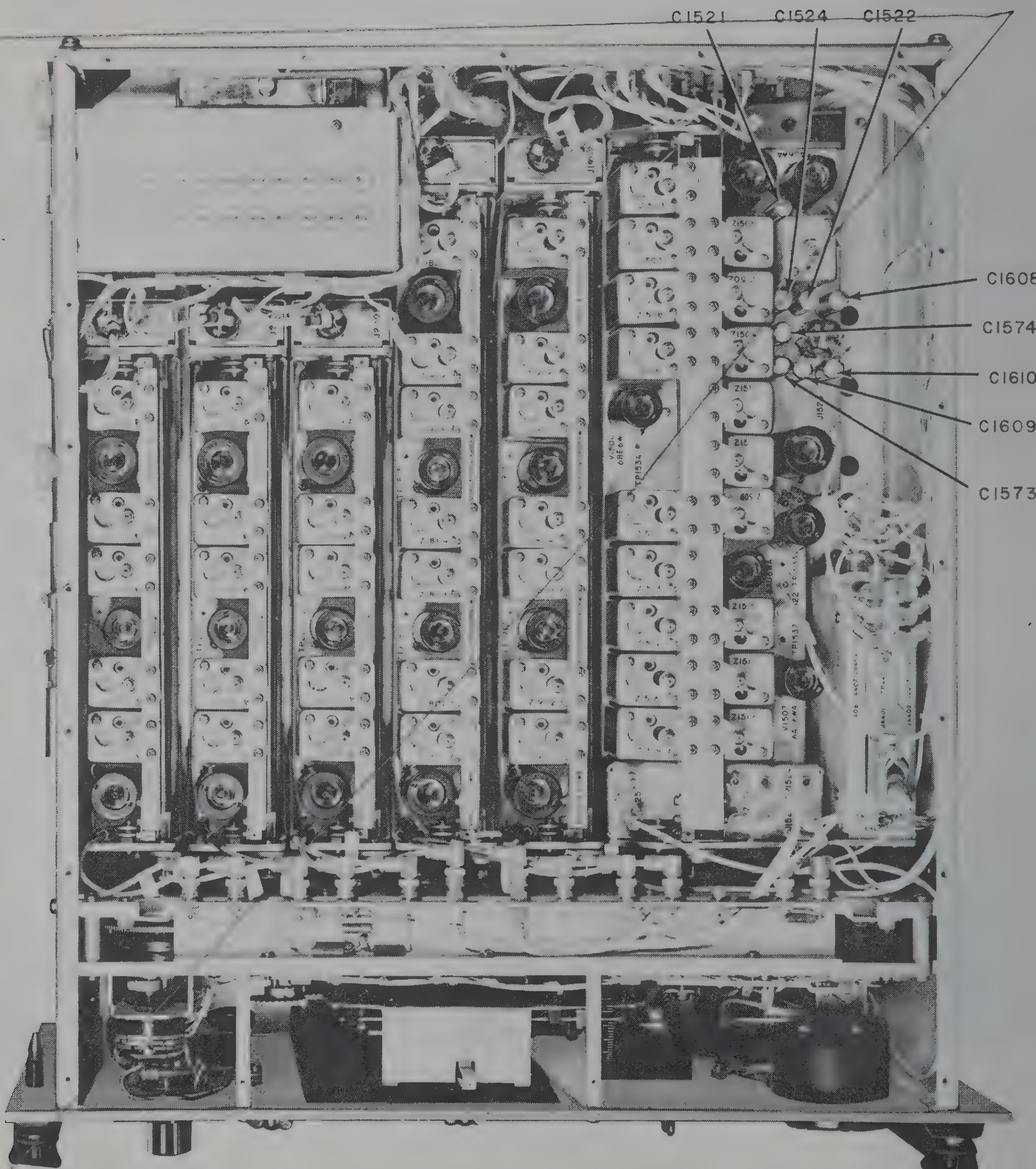


Figure 109. Exciter-monitor, front view, front panel removed, location of minor components.

Supsd
C1



TM 5820-215-35-143

~~*Figure 110. Exciter-monitor, location of capacitors, top view.*~~

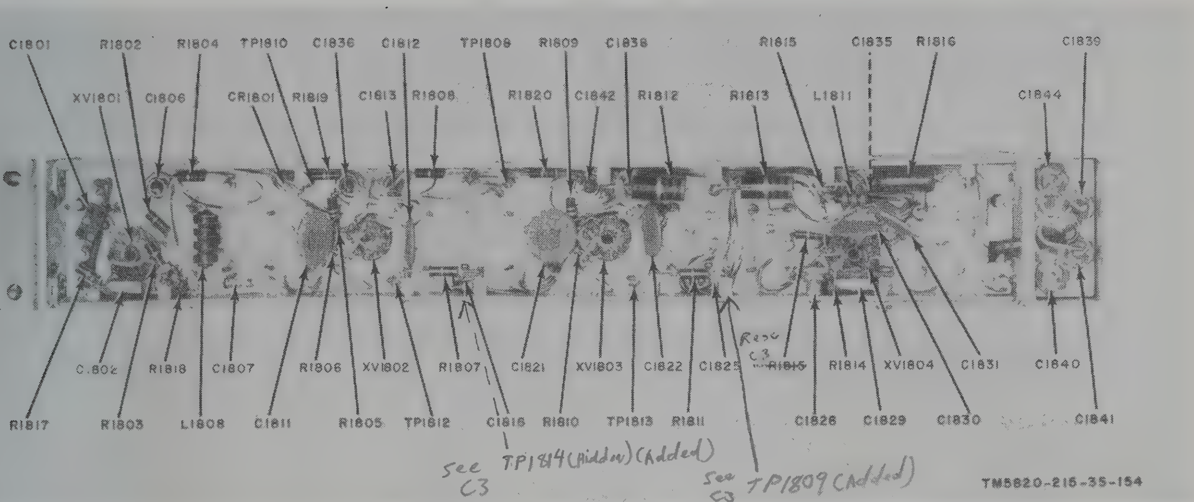


Figure 111. Exciter-monitor, band 1 mixer-amplifier subchassis, bottom view.

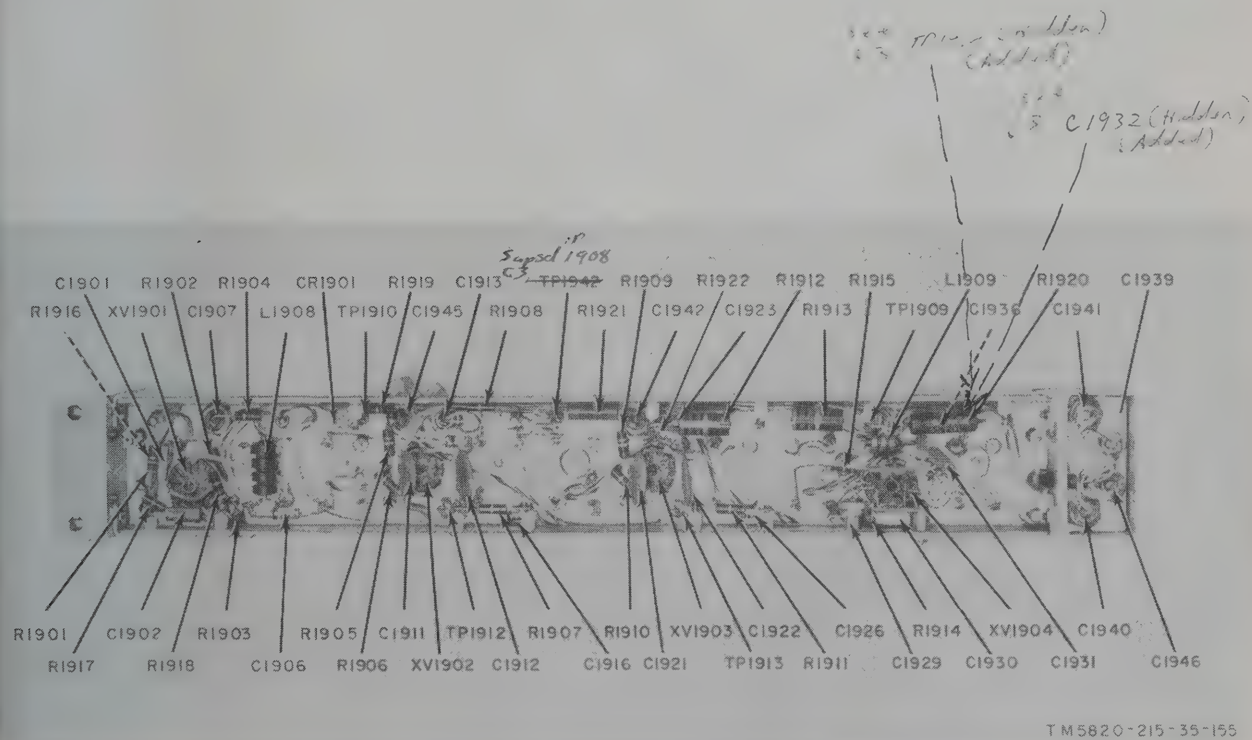


Figure 112. Exciter-monitor, band 2 mixer-amplifier, bottom view.

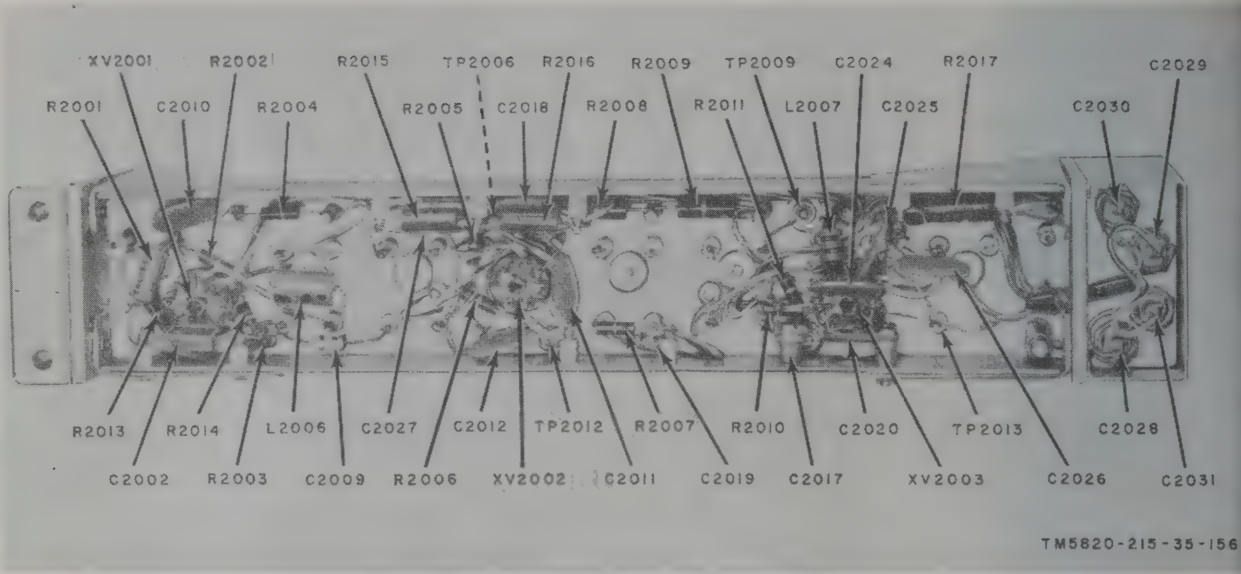


Figure 113. Exciter-monitor, band 3 mixer-amplifier, bottom view.

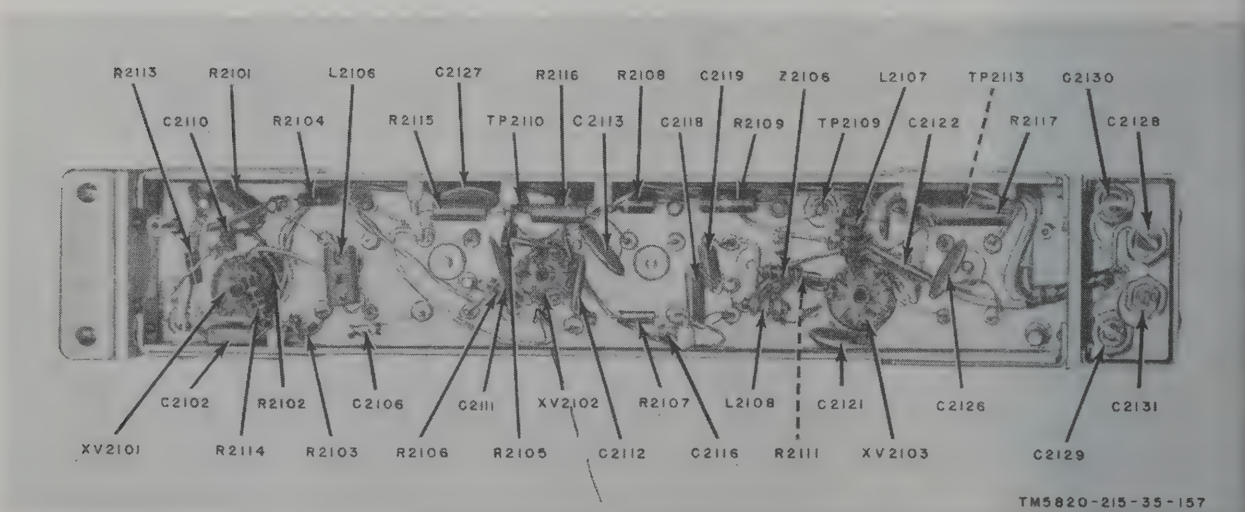


Figure 114. Exciter-monitor, band 4 mixer-amplifier, bottom view.

TP2112

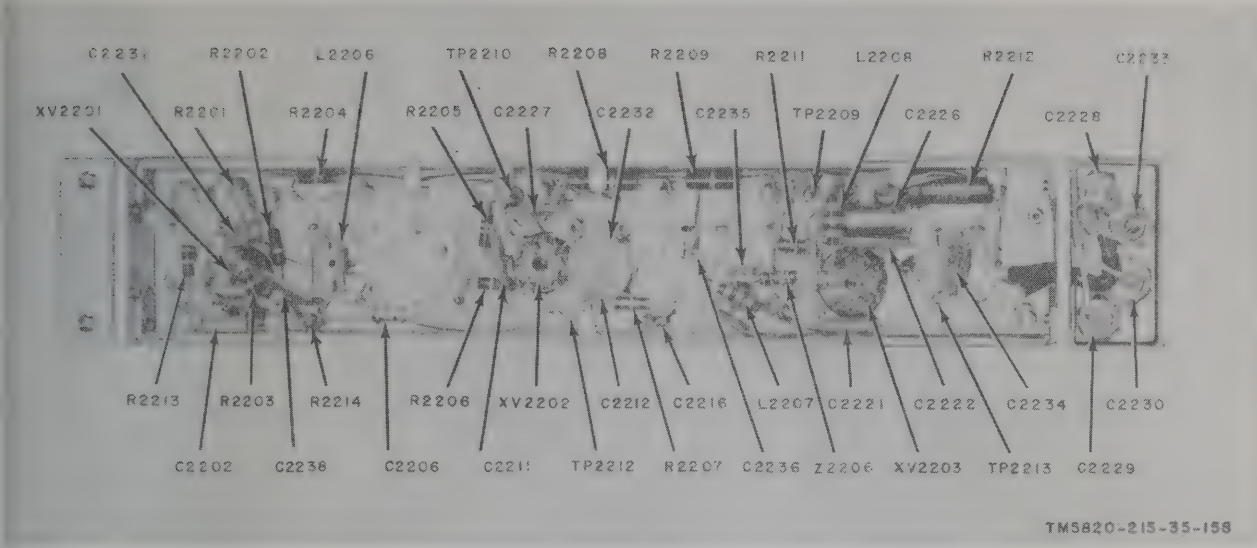


Figure 115. Exciter-monitor, band 5 mixer-amplifier, bottom view.

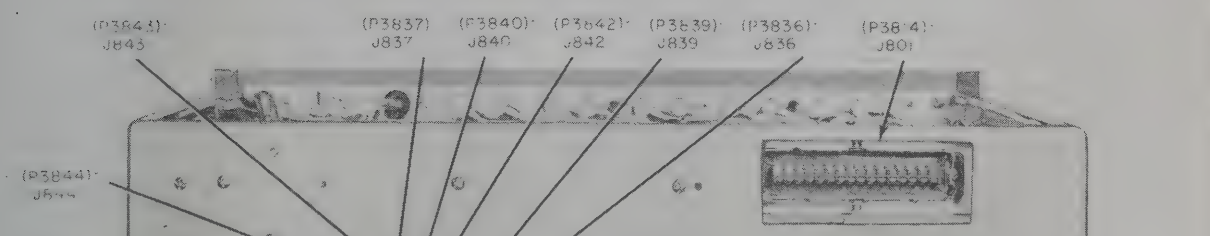


Figure 116. Exciter-monitor, location of plugs and jacks, rear view.

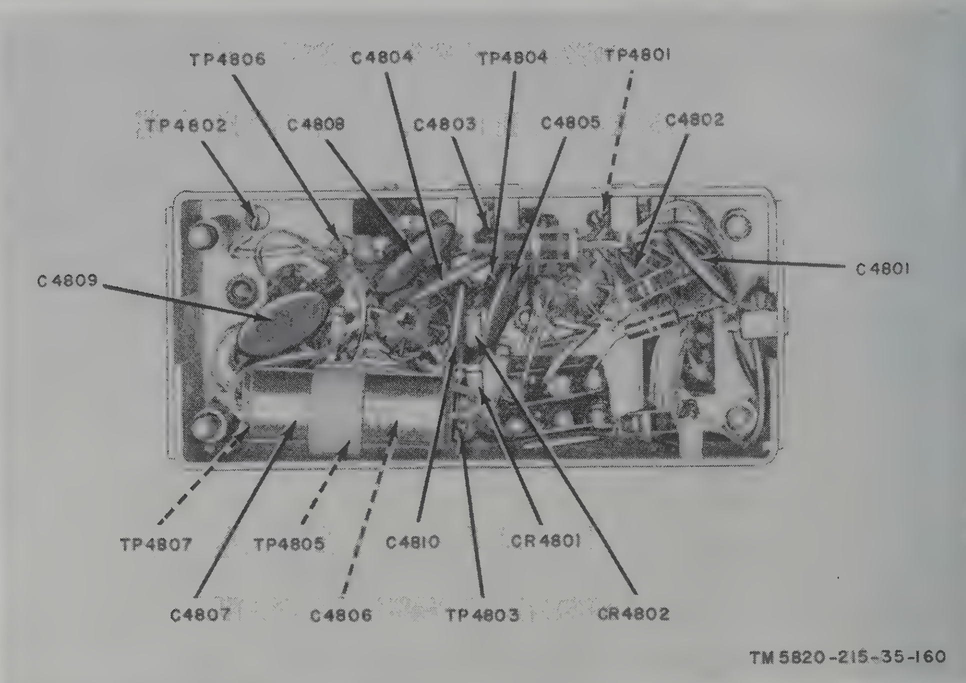


Figure 117. Exciter-monitor, phase lock indicator subchassis, bottom view showing capacitors.

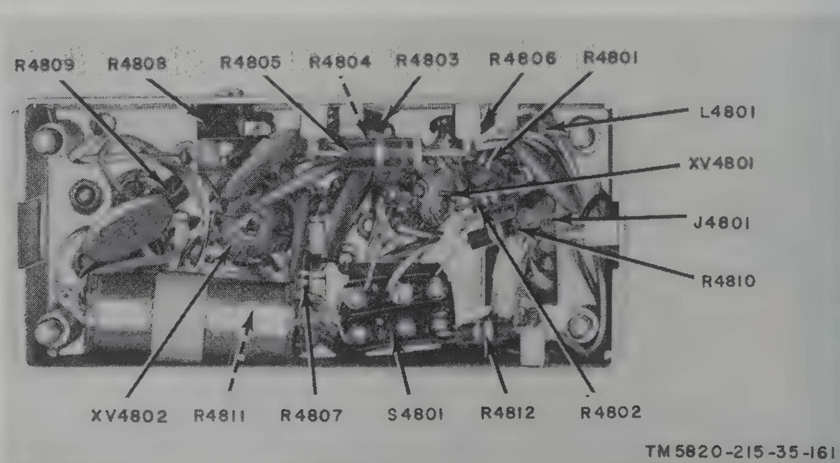


Figure 118. Exciter-monitor, phase lock indicator subchassis, bottom view showing resistors.

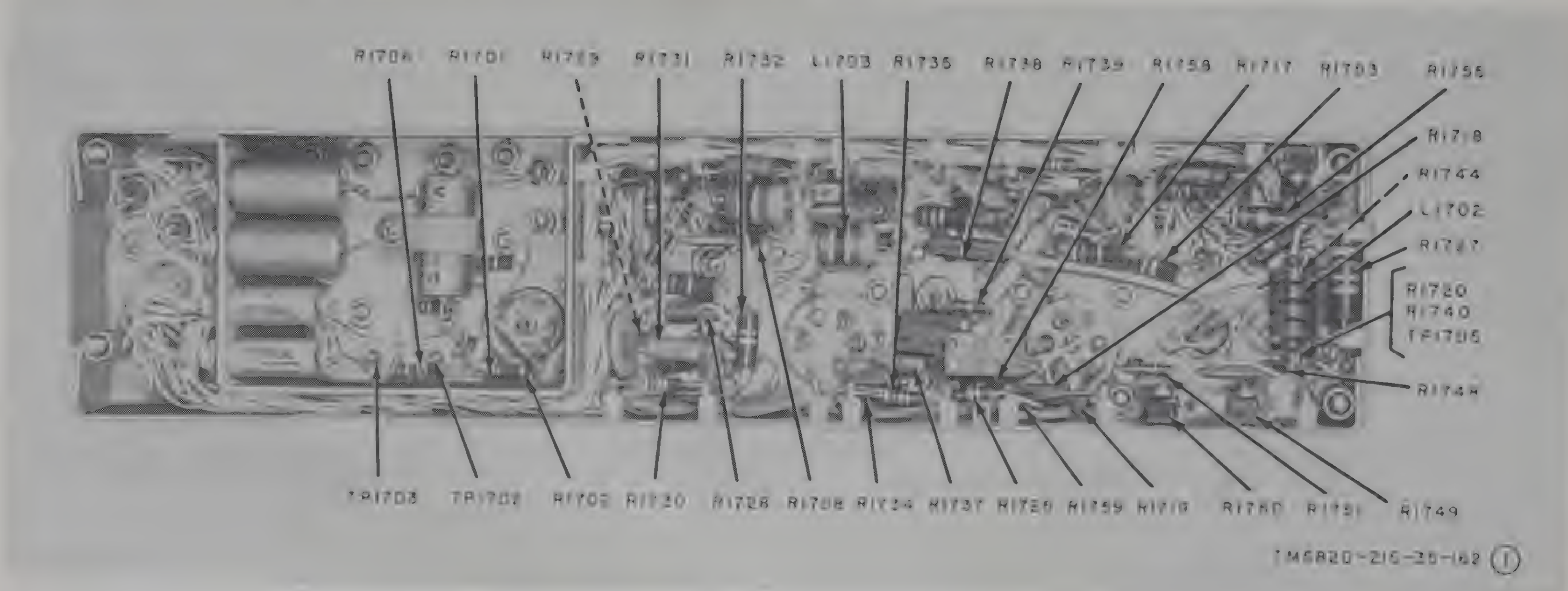


Figure 119 Exciter-monitor, smo error detector subchassis, bottom view showing resistors (Part 1 of 2).

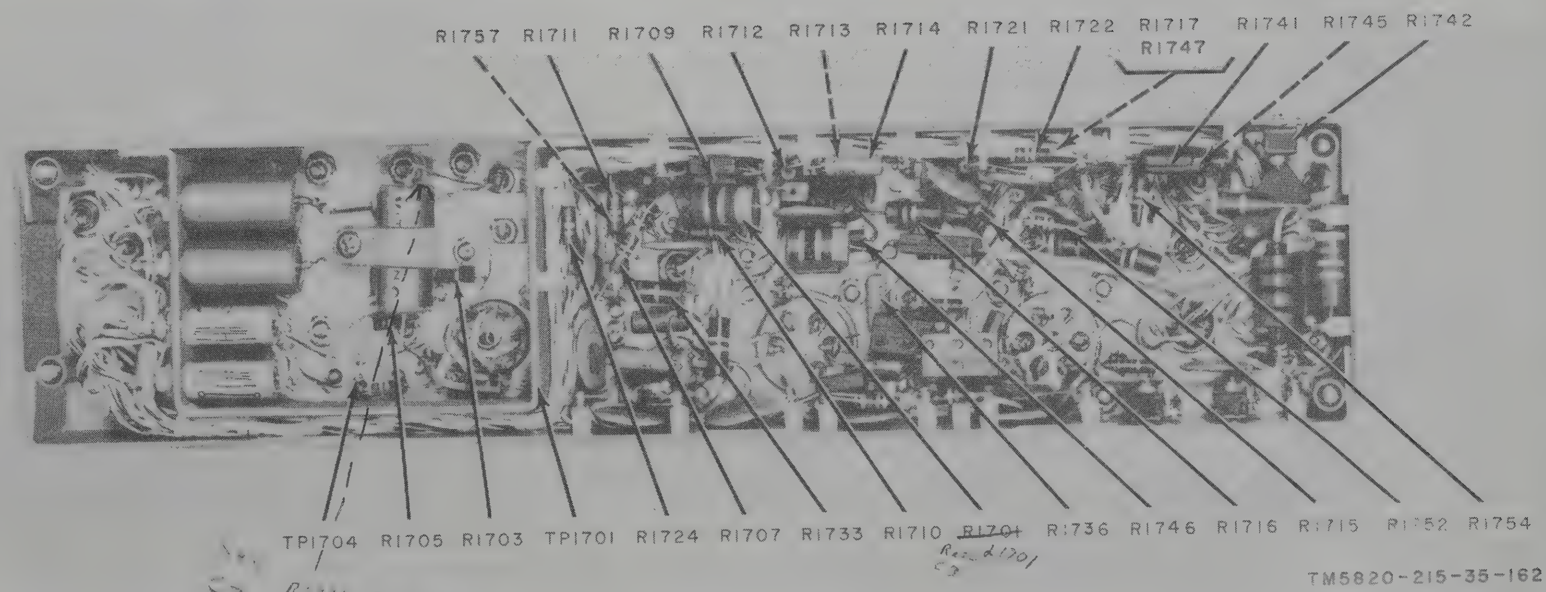


Figure 119—Continued *(Part 2 of 2).*

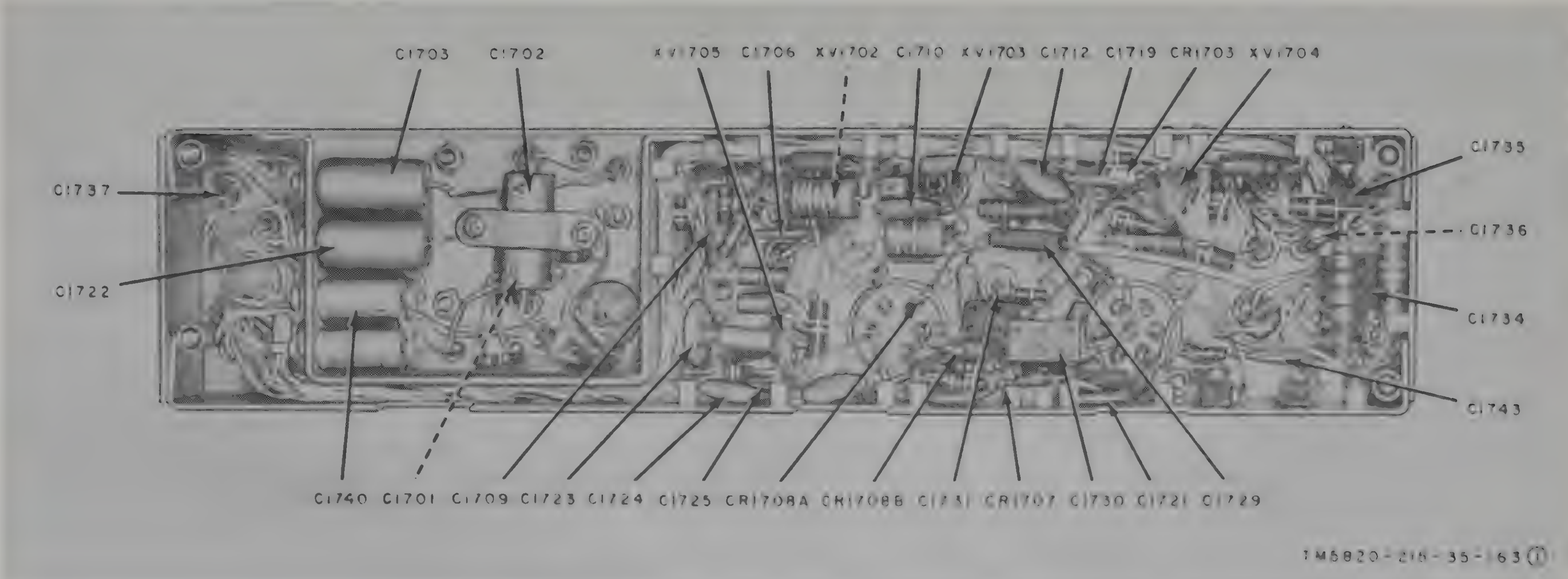


Figure 120. Exciter-monitor, smo error detector subchassis, bottom view showing capacitors (Part 1 of 2).

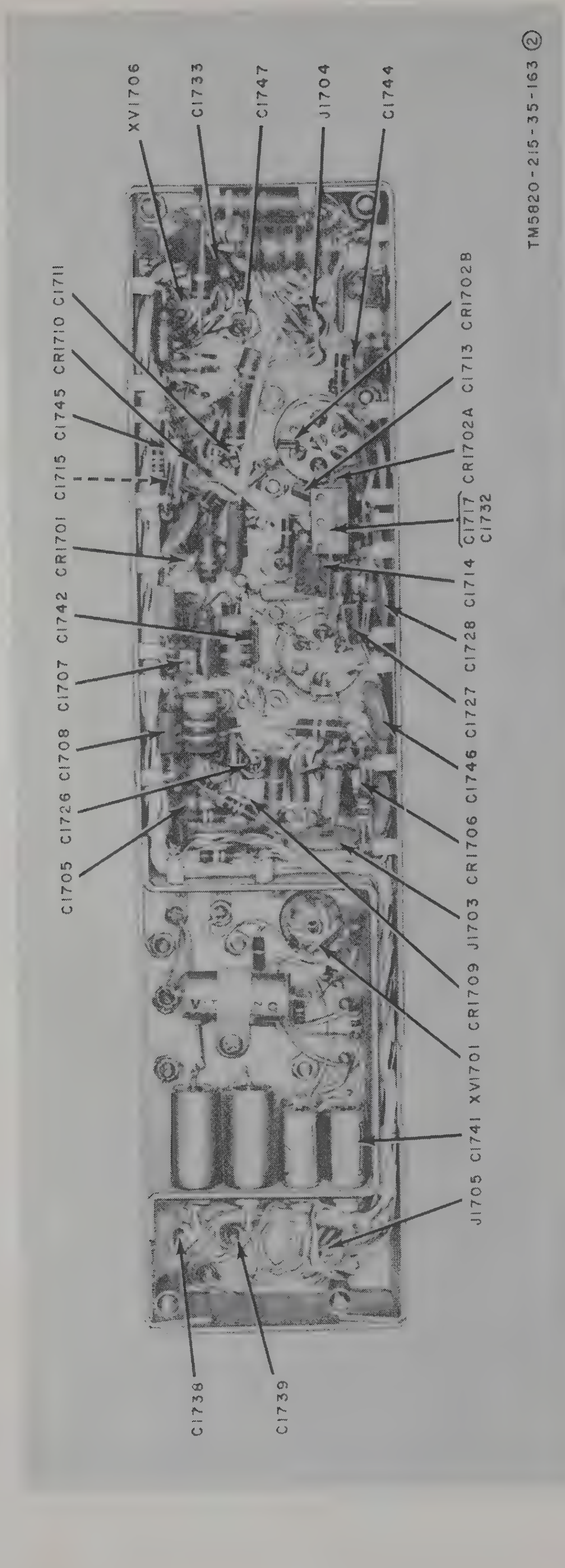


Figure 120—Continued (*Part 2 of 2*)

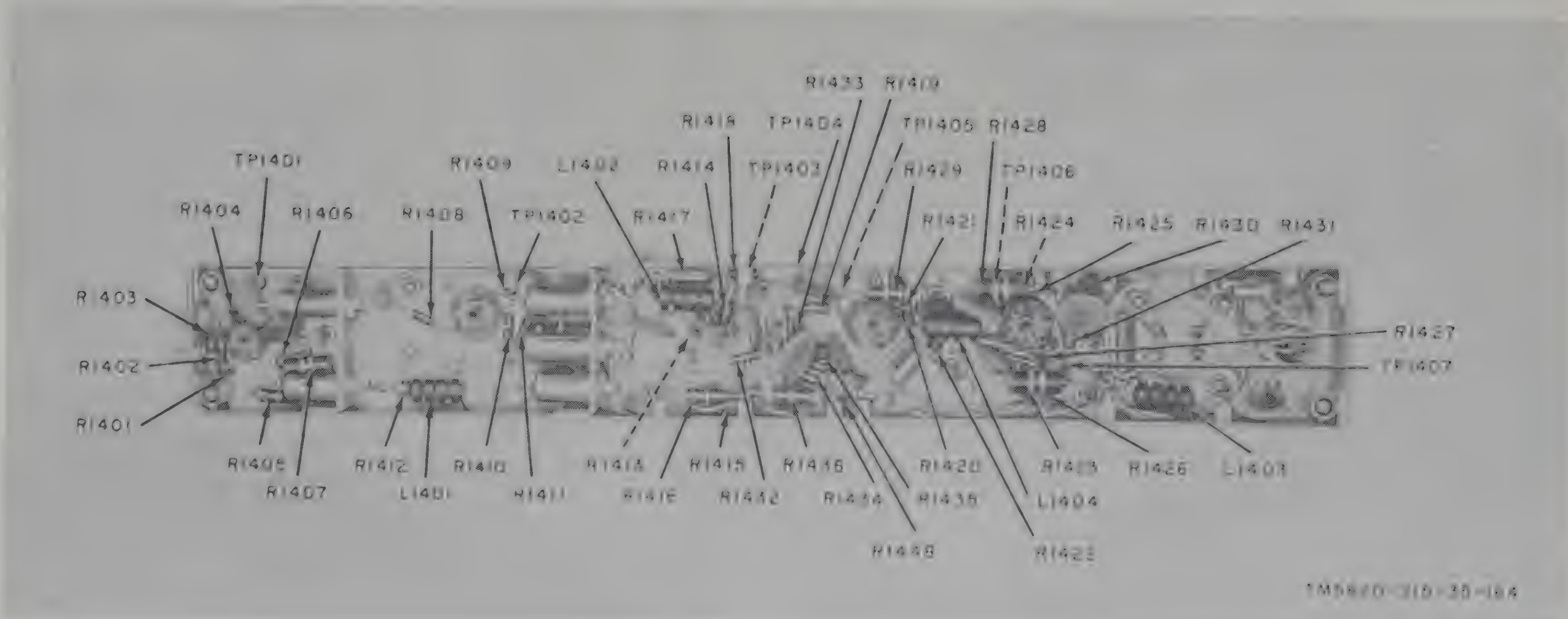


Figure 121. Exciter-monitor, monitor subchassis, bottom view showing resistors.

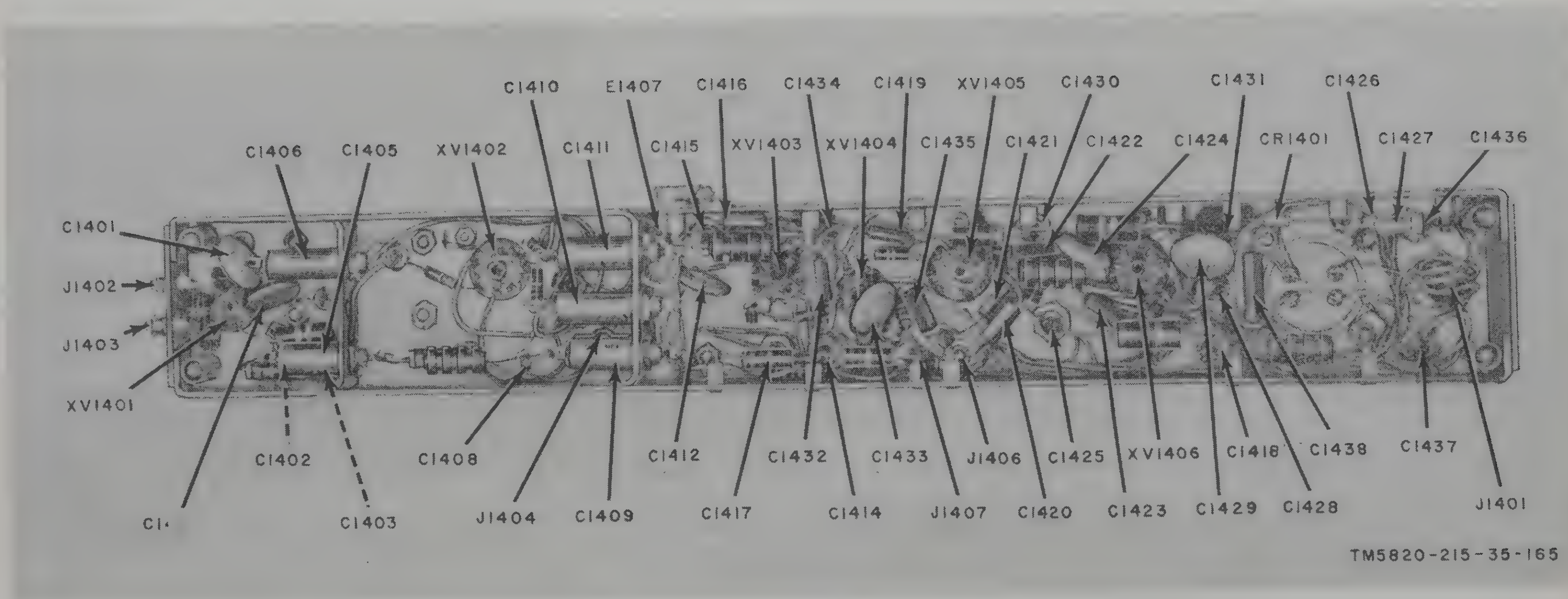


Figure 122. Exciter-monitor, monitor subchassis, bottom view showing capacitors.

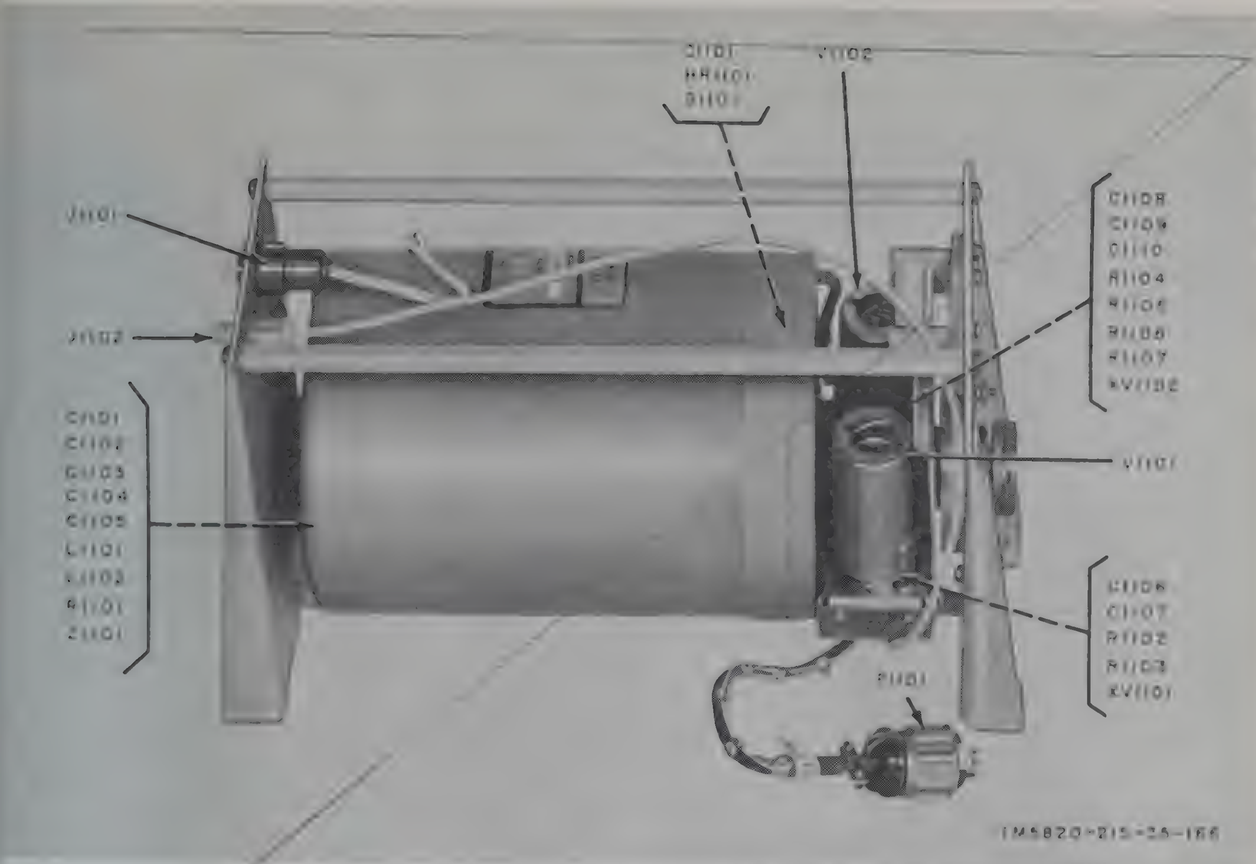


Figure 123. Exciter-monitor, smo subchassis, location of components.

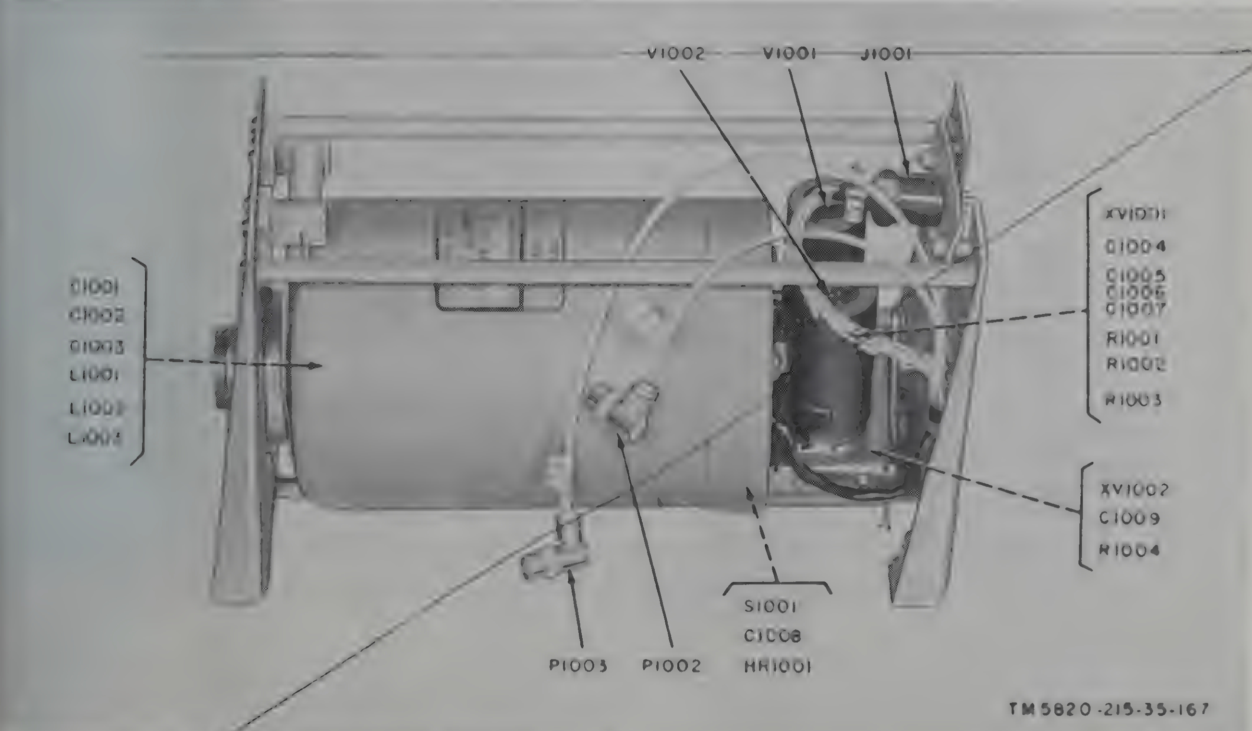


Figure 124. Exciter-monitor, interpolation oscillator subchassis, location of components.

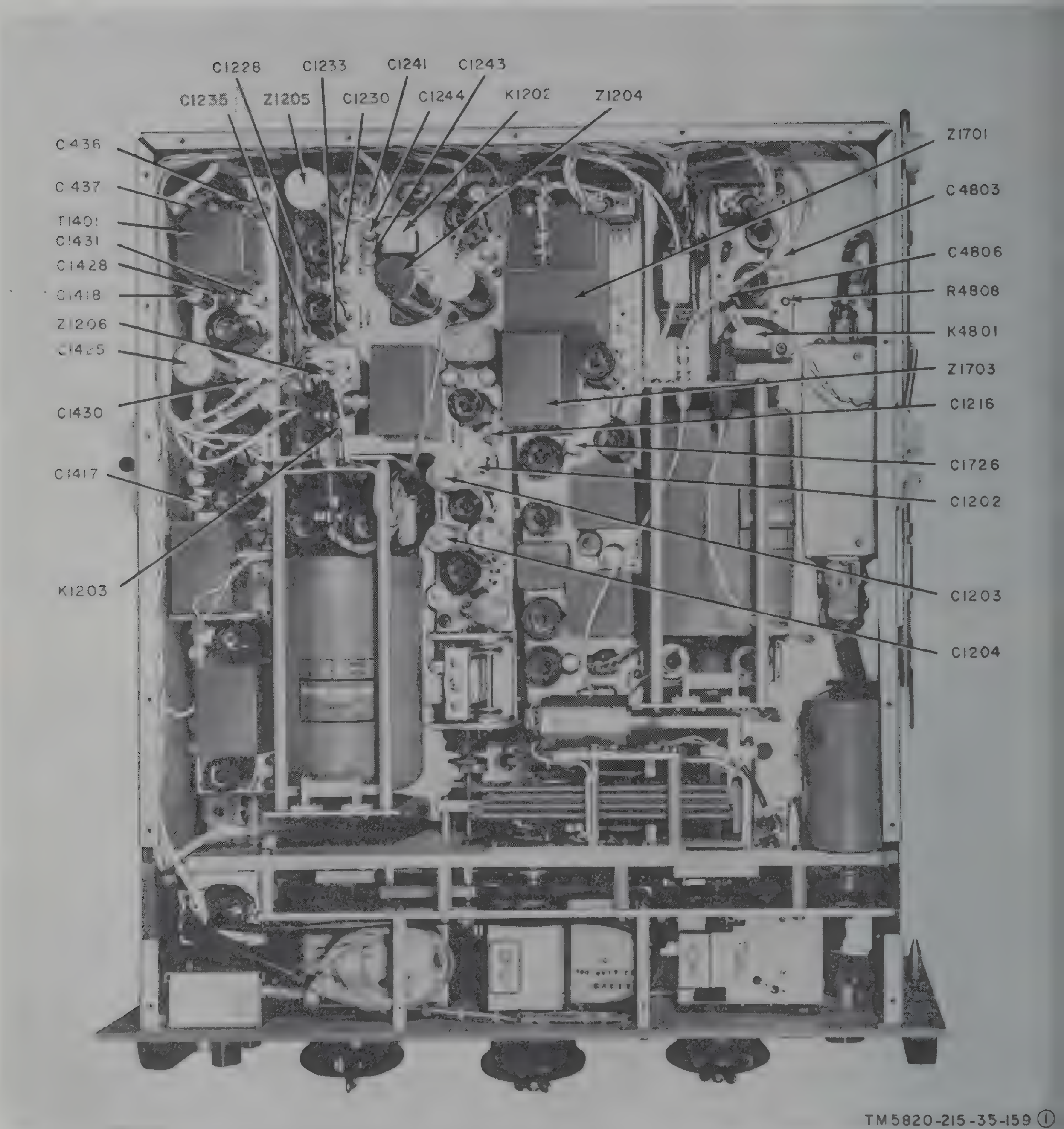


Figure 125. Exciter-monitor, location of components, bottom view (Part 1 of 2).

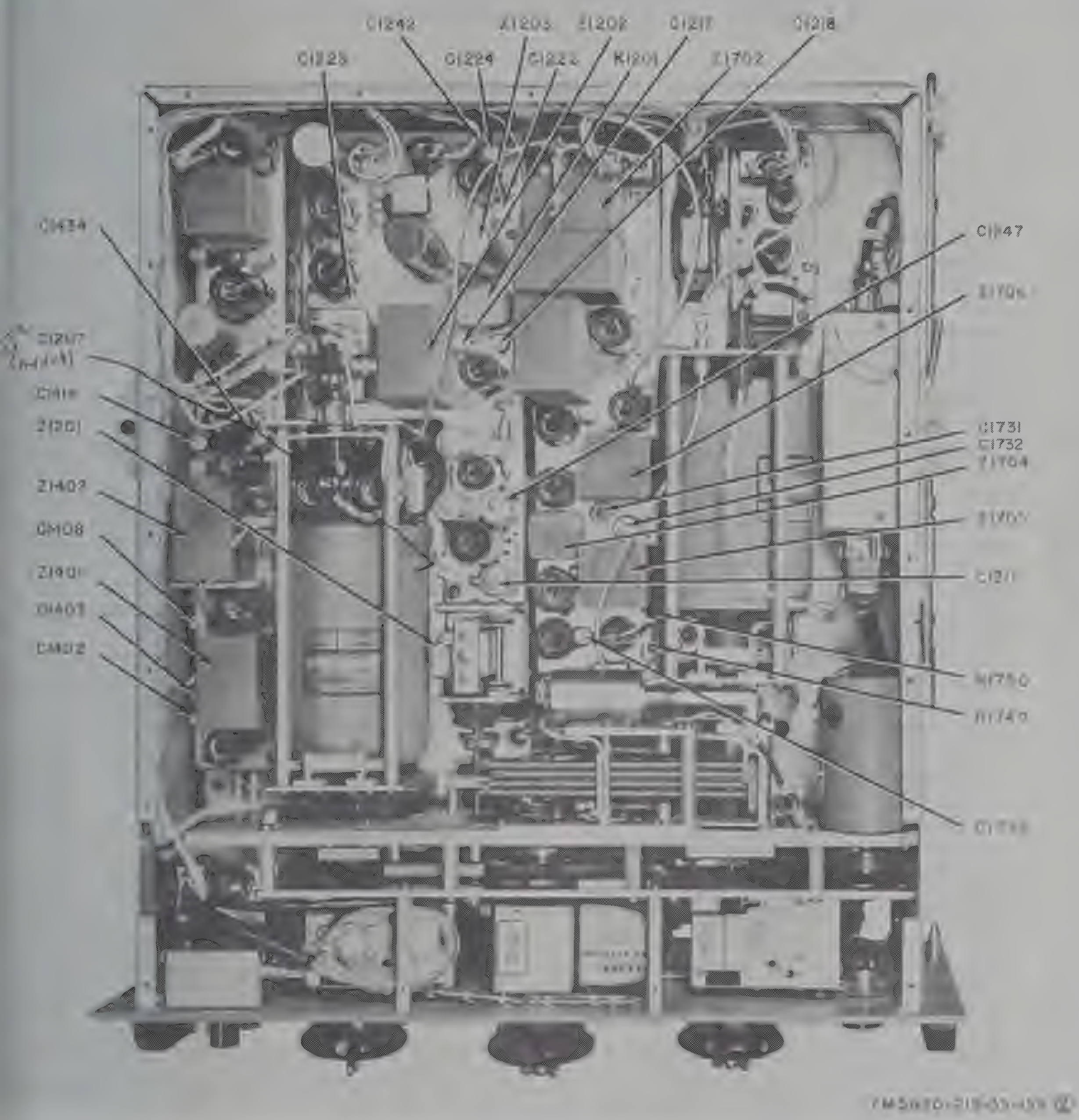


Figure 125—Continued *(Part 2 of 2).*

120. Test Point Measurements

The test point measurements in the tables list the average of several actual measurements taken on operating units. The readings given should be used as a guide rather than as a rigid standard. Readings taken on units in operation will vary from the readings on the charts in many cases because of tolerance in the components, meter calibration, and accuracy of the readings taken. The readings in the tables should be used with the troubleshooting charts (par. 115 through 119) and each reading evaluated with the symptom listed in the chart. Use Multimeter ME–26/U for all voltage measurements and the OS–8/U for all waveform (fig. 126) observations.

a. Frequency Standard Compartment.

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP501	Z503	25 kc	....	....	30 ac rms
TP502	100-kc output	100 kc	....	....	2 ac rms
TP503	Cathode V503	Dc	....	....	+8
TP504	Cathode V501	Dc	....	....	+0.6
TP505	250-kc output	250 kc	....	....	3 ac rms
TP506	Cathode V502	Dc	....	With input signal	+6.6
TP506	Cathode V502	Dc	....	No input signal	+4.5
TP507	Cathode V504	Dc	....	....	+5
TP511	Z501	75 kc	....	....	110 ac rms
TP511	Z501	Dc	....	....	+120
TP512	Z502	250 kc	....	....	235 ac rms
TP512	Z502	Dc	....	....	+280
TP514	Z504	100 kc	....	....	100 ac rms
TP514	Z504	Dc	....	....	+250
TP515	Z505	100 kc	....	....	55 ac rms
TP516	Z506	250 kc	....	....	100 ac rms
TP516	Z506	Dc	....	....	+250
TP517	Z507	250 kc	....	....	100 ac rms
TP602	Cathode V602	Dc	....	....	+0.5
TP603	Cathode V603	Dc	....	....	+0.7
TP604	Cathode V604	Dc	....	....	+0.9
TP605	Cathode V606A	Dc	....	....	+0.8
TP606	Cathode V606B	Dc	....	....	+20
TP607	Cathode V607	Dc	....	....	+13.5
TP901	Injector grid V901	1 mc	....	....	4 ac rms
TP902	300-kc output	300 kc	....	....	3 ac rms
TP903	100-kc output	100 kc	....	....	4 ac rms
TP904	Cathode V901	Dc	....	With input signal	+1.5
TP904	Cathode V901	Dc	....	No input signal	+1.2
TP911	Z901	100 kc	....	....	29 ac rms
TP911	Plate V901	Dc	....	....	+250
TP912	Plate V902A	900 kc	....	....	65 ac rms
TP912	Plate V902A	Dc	....	With input signal	+145
TP912	Plate V902A	Dc	....	No input signal	+100
TP1301	Primary Z1302	25 kc	....	....	30 ac rms
TP1303	Grid (pin 7) V1301	10 kc	See A, fig. 126	....	13 ac rms
TP1303	Grid (pin 7) V1301	Dc	....	With input signal	−21
TP1303	Grid (pin 7) V1301	Dc	....	No input signal	−0.2
TP1305	1-kc output	1 kc	....	....	25 ac rms
TP1306	Grid (pin 7) V1302	2 kc	See B, fig. 126	....	14 ac rms
TP1306	Grid (pin 7) V1302	Dc	....	No input signal	−0.66
TP1306	Grid (pin 7) V1302	Dc	....	With input signal	−23
TP1311	Cathode V1301	Dc	....	With input signal	+10
TP1311	Cathode V1301	Dc	....	No input signal	+4.6
TP1312	Cathode V1302	Dc	....	With input signal	+1.3
TP1312	Cathode V1302	Dc	....	No input signal	+2.3
TP4701	Cathode V4702A	Dc	....	With input signal	+4

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP4701	Cathode V4702A	Dc		No input signal	+2.6
TP4702	4.5-kc output	4.5 kc			4 ac rms
TP4703	Cathode V4702B	Dc		With input signal	+3.8
TP4703	Cathode V4702B	Dc		No input signal	+2.6

b. Tsb Modulator.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP201	Z201	100 kc		130 ac rms
TP201	Z201	Dc		+250
TP202	Cathode V202	Dc		+2
TP203	Cathode V203	Dc		+2
TP207	Cathode V201	Dc	No carrier reinsertion	+1.2
TP207	Cathode V201	Dc	Carrier reinserted by pa tuneup (modulation disabled)	+64
TP401	Z401	300-kc tsb	Apply one tone of standard two-tone signal with alc switch set to OFF.	0.14 ac rms
TP401	Z401	Dc	Same as above	+260
TP402	Z402	300-kc tsb	Same as above	0.07 ac rms
TP403	Z403	300-kc tsb	Same as above	0.55 ac rms
TP404	Cathode V402	Dc	Same as above	+3
TP406	Control grid V401	300-kc tsb	Same as above	0.01 ac rms
TP407	Cathode V401	Dc	Same as above	+2.5
TP4101	Control grid V4101A (100-kc input)	100 kc		2 ac rms
TP4102	Control grid V4101B	200 kc		3.5 ac rms
TP4103	Z104 (400-kc output)	400 kc		2.8 ac rms
TP4111	Z4101	100 kc		4 ac rms
TP4112	Z4102	200 kc		50 ac rms
TP4112	Z4102	Dc	With 100-kc input	+116
TP4112	Z4102	Dc	No 100-kc input	+53
TP4113	Z4103	400 kc		40 ac rms
TP4113	Z4103	Dc	With 100-kc input	+83
TP4113	Z4103	Dc	No 100-kc input	+47
TP4114	Z4104	400 kc		17 ac rms
TP4201	Control grid V4201	100-kc tsb	No carrier. Apply one tone of standard two-tone test signal.	0.017 ac rms
TP4202	V4201 cathode	Dc		+2.6
TP4501	Input to V4501	300-kc tsb	Apply one tone of standard two-tone test signal.	0.2 ac rms
TP4502	Cathode V4501	Dc	Same as above	+2
TP4503	Cathode CR4501	Dc	Same as above	+4.4
TP4506	Cathode V4502A	Dc	Set AGC switch to BAL	+1.7
TP4507	Cathode V4502B	Dc	Set AGC switch to BAL	+1.3

c. Exciter-Monitor—Smo RF Section.

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP1501	Z1501	100 kc			90 ac rms
TP1501	Z1501	Dc			+200
TP1502	Z1502	2.65-4.65 mc	See C, fig. 126	Band 2, 2.3500 mc	4.4 ac rms
TP1502	Z1502	Dc		Band 2, 2.3500 mc	+60
TP1502	Z1502	2.65-4.65 mc	See D, fig. 126	Band 2, 4.3500 mc	3.8 ac rms

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP1502	Z1502	Dc	....	Band 2, 4.3500 mc	+60
TP1503	Z1503	4.65-8.65 mc	See E, fig. 126	Band 3, 4.3500 mc	3 ac rms
TP1503	Z1503	Dc	....	Band 3, 4.3500 mc	+60
TP1503	Z1503	4.65-8.65 mc	See F, fig. 126	Band 3, 8.3500 mc	2.2 ac rms
TP1503	Z1503	Dc	....	Band 3, 8.3500 mc	+60
TP1504	Z1504	4.65-8.65 mc	See G, fig. 126	Band 3, 4.3500 mc	0.1 ac rms
TP1504	Z1504	4.65-8.65 mc	See H, fig. 126	Band 3, 8.3500 mc	0.1 ac rms
TP1505	Z1505	8.65-16.65 mc	See I, fig. 126	Band 4, 8.3500 mc	2.2 ac rms
TP1505	Z1505	Dc	....	Band 4, 8.3500 mc	+60
TP1505	Z1505	8.65-16.65 mc	See J, fig. 126	Band 4, 16.3500 mc	3 ac rms
TP1505	Z1505	Dc	....	Band 4, 16.3500 mc	+60
TP1506	Z1506	8.65-165 mc	See K, fig. 126	Band 4, 8.3500 mc	0.06 ac rms
TP1506	Z1506	8.65-16.65 mc	See L, fig. 126	Band 4, 16.3500 mc	0.06 ac rms
TP1507	Z1507	16.65-32.65 mc	See M, fig. 126	Band 5, 16.3500 mc	4 ac rms
TP1507	Z1507	Dc	....	Band 5, 16.3500 mc	+60
TP1507	Z1507	16.65-32.65 mc	See N, fig. 126	Band 5, 32.3500 mc	3.5 ac rms
TP1507	Z1507	Dc	....	Band 5, 32.3500 mc	+60
TP1508	Z1508	16.65-32.65 mc	See O, fig. 126	Band 5, 16.3500 mc	0.15 ac rms
TP1508	Z1508	16.65-32.65 mc	See P, fig. 126	Band 5, 32.3500 mc	0.15 ac rms
TP1509	Z1509	2 mc	....	Band 2, 2.3000 mc	18 ac rms
TP1509	Z1509 (plate of V1503)	Dc	....	Band 2, 2.3000 mc	+260
TP1509	Z1509	4 mc	....	Band 2, 4.3000 mc	17 ac rms
TP1509	Z1509	Dc	....	Band 2, 4.3000 mc	+260
TP1510	Z1510	2 mc	....	Band 2, 2.3000 mc	15 ac rms
TP1510	Z1510	4 mc	....	Band 2, 4.3000 ac	15 ac rms
TP1511	Z1511	2.65-4.65 mc	See Q fig. 126	Band 2, 2.3500 mc	0.6 ac rms
TP1511	Z1511 (plate of V1504)	Dc	....	Band 2, 2.3500 mc	+240
TP1511	Z1511	2.65-4.65 mc	See R, fig. 126	Band 2, 4.3500 mc	0.38 ac rms
TP1511	Z1511 (plate of V1504)	Dc	....	Band 2, 4.3500 mc	+240
TP1512	Z1512	2.65-4.65 mc	See S, fig. 126	Band 2, 2.3500 mc	0.3 ac rms
TP1512	Z1512	2.65-4.65 mc	See T, fig. 126	Band 2, 4.3500 mc	0.3 ac rms
TP1513	Z1513	6 mc	....	Band 3, 4.3000 mc *Note.* Meter probe will cause detuning.	24 ac rms
TP1513	Z1513	12 mc	....	Band 3, 8.3000 mc *Note.* Meter probe will cause detuning.	19 ac rms
TP1513	Z1513 (plate of V1506)	Dc	....	Band 3, 8.3000 mc	+270
TP1514	Z1514	14 mc	....	Band 5, 16.3000 mc	2.1 ac rms
TP1514	Z1514	Dc	....	Band 5, 16.3000 mc	+270
TP1514	Z1514	28 mc	....	Band 5, 32.3000 mc	1 ac rms
TP1514	Z1514	Dc	....	Band 5, 32.3000 mc	+270
TP1515	Z1515	14 mc	....	Band 5, 16.3000 mc	0.6 ac rms
TP1515	Z1515	28 mc	....	Band 5, 32.3000 mc	0.5 ac rms
TP1516	Z1516	6 mc	....	Band 3, 4.3000 mc	18 ac rms
TP1516	Z1516 (plate of V1507)	Dc	....	Band 3, 4.3000 mc	+260
TP1516	Z1516	12 mc	....	Band 3, 8.3000 mc	9 ac rms
TP1516	Z1516	Dc	....	Band 3, 4.3000 mc	+260
TP1517	Z1517	6 mc	....	Band 3, 4.3000 mc	8 ac rms
TP1517	Z1517	12 mc	....	Band 3, 8.2000 mc	6 ac rms
TP1518	Z1518	14 mc	....	Band 5, 16.3000 mc	8 ac rms
TP1518	Z1518 (plate of V1507)	Dc	....	Band 5, 16.3000 mc	+260
TP1518	Z1518	28 mc	....	Band 5, 32.3000 mc	4 ac rms
TP1518	Z1518	Dc	....	Band 5, 32.3000 mc	+260

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP1519	Z1519	14 mc	....	Band 5, 16.3000 mc	5 ac rms
TP1519	Z1519	28 mc	....	Band 5, 32.3000 mc	3.8 ac rms
TP1521	Input to V1501	100 kc	....	....	2 ac rms
TP1522	Input to V1503	2 mc	....	Band 2, 2.3000 mc	2 ac rms
TP1522	Input to V1503	4 mc	....	Band 2, 4.3000 mc	2 ac rms
TP1524	Output of V1503	2 mc	....	Band 2, 2.3000 mc	2.2 ac rms
TP1524	Output of V1503	4 mc	....	Band 2, 4.3000 mc	2.2 ac rms
TP1527	Output of V1507	6 mc	....	Band 3, 4.3000 mc	2.5 ac rms
TP1527	Output of V1507	12 mc	....	Band 3, 8.3000 mc	2.2 ac rms
TP1528	Z1519 output	14 mc	....	Band 5, 16.3000 mc	2.2 ac rms
TP1528	Z1519 output	28 mc	....	Band 5, 32.3000 mc	2.2 ac rms
TP1531	Cathode V1501	Dc	....	....	+1.5
TP1532	Cathode V1502	Dc	....	....	+9
TP1533	Grid V1503	Dc	....	....	−4
TP1534	Cathode V1504	Dc	....	....	+2.6
TP1535	Cathode V1505	Dc	....	....	+2.6
TP1537	Grid V1507	Dc	....	....	−0.5

d. Exciter-Monitor—0.5-Kc Spectrum Detent.

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP1201	Z1201	700 kc	See U, fig. 126	0.5 KC LOCK ON, set FREQ-KC dial to 0.	2 ac rms
TP1201	Z1201	Dc	....	Same as above	+40
TP1201	Z1201	600 kc	See V, fig. 126	0.5 KC LOCK ON, set FREQ-KC dial to 99.5 kc.	2 ac rms
TP1201	Z1201	Dc	....	Same as above	+40
TP1202	Cathode V1202	Dc	....	0.5 KC LOCK ON	+7
TP1202	Cathode V1202	Dc	....	0.5 KC LOCK OFF	+3.2
TP1203	Cathode V1203	Dc	....	0.5 KC LOCK ON	+2.4
TP1204	Cathode V1204	Dc	....	0.5 KC LOCK ON	+2.4
TP1205	Cathode V1205	Dc	....	0.5 KC LOCK ON	+0.03
TP1205	Cathode V1205	Dc	....	0.5 KC LOCK OFF	+0.2
TP1206	Z1206	250 kc	See W, fig. 126	0.5 KC LOCK ON, set FREQ-KC dial to 0 kc.	16 ac rms
TP1206	Z1206	250 kc	....	0.5 KC LOCK ON, set FREQ-KC dial to 00.5 kc.	16 ac rms
TP1206	Z1206	Dc	....	0.5 KC LOCK ON	+250
TP1206	Z1206	Dc	....	0.5 KC LOCK OFF	+300
TP1207	Cathode V1206	Dc	....	0.5 KC LOCK ON	+3
TP1207	Cathode V1206	Dc	....	0.5 KC LOCK OFF	0
J1201	1-kc input to V1201	1 kc	....	....	25 ac rms
J1202	340-450-kc input to V1203	450 kc	....	FREQ-KC dial set to 0 kc	1.2 ac rms
J1202	350-450-kc input to V1203	350 kc	....	FREQ-KC dial set to 99.5 kc	1.3 ac rms
J1202	350-450-kc input to V1203	Dc	....	....	+11
J1203	5-kc input to K1202	5 kc	....	FREQ-KC dial set to 0 kc	1.5 ac rms
J1203	5-kc to K1202	5 kc	....	FREQ-KC dial set to 00.5 kc	0 ac rms

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
J1204	4.5-kc input to K1202	4.5 kc	....	FREQ-KC dial set to 00.5 kc	1.5 ac rms
J1204	4.5-kc input to K1202	4.5 kc	....	FREQ-KC dial set to 0 kc	0 ac rms
J1205	0.5-kc spectrum detent output	250 kc ±250 cps	....	0.5 KC LOCK ON	4.5 ac rms
J1205	0.5-kc spectrum detent output	250 kc	....	0.5 KC LOCK OFF	3 ac rms

e. Exciter-Monitor—Smo Error Detector.

Test point	Circuit being measured	Frequency	Waveform	Condition of measurement	Normal reading (all readings in volts)
TP1701	Cathode V1701	Dc	....	....	+3
TP1702	Control grid V1701A	700 kc	....	Band 2, 2.3000 mc	0.3 ac rms
TP1703	Control grid V1701B	450 kc	....	Band 2, 2.3000 mc	2.7 ac rms
TP1704	Bias voltage V1701B	Dc	....	MC wingnut locked	0
TP1704	Bias voltage V1701B	Dc	....	Press MANUAL TUNE button	−105
TP1705	Frequency discriminator	Dc	....	Input signal present	0 ±1
TP1706	Control grid V1706	Dc	....	Input signal present	0 ±0.1
J1702	Output of interpolation oscillator cathode follower V1002B	450 kc	....	FREQ-KC dial on 0	2 ac rms

f. Exciter-Monitor—Phase Lock Indicator.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts, except TP4807)
TP4801	Cathode V4801	Dc	....	+1.5
TP4802	Cathode V4802	Dc	....	+0.2
TP4803	Control grid V4802	Dc	....	+1.5
TP4803	Control grid V4802	Dc	Press MANUAL TUNE button	0±0.3
TP4803	Control grid V4802	Dc	Band 2, 2.3000 mc, ground TP1706	−11
TP4804	Input V4802	Dc	....	+3.8
TP4804	Input V4802	Dc	Press MANUAL TUNE button	+3
TP4804	Input V4802	Dc	Band 2, 2.3000 mc, ground TP1706	+13.8
TP4805	V4802 grid 2	Dc	Band 2, 2.3000 mc	+9
TP4805	V4802 grid 2	Dc	Band 4, 8.3000 mc	+8
TP4805	V4802 grid 2	Dc	Band 5, 16.3000 mc	+6
TP4805	V4802 grid 2	Dc	Band 5, 16.3000 mc, 0.5 KC LOCK OFF, S4801 on ADJ	+3
TP4806	STABILIZED light indicator circuit	Dc	All wingnuts locked	0
TP4806	STABILIZED light indicator	Dc	Press MANUAL TUNE button	+25
TP4807	K4801	0	....	Infinity ohms to ground
TP4807	K4801	0	Press MANUAL TUNE button	0 ohm to ground.

g. Exciter-Monitor—Band 1 Mixer-Amplifier.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP1801	Z1801	1.7 mc	Band 1, 1.7000 mc, LEVEL controls on tsb modulator set to 0, agc bias R4513 set for 1 volt.	0.3 ac rms
TP1801	Z1801	Dc	Same as above	+260
TP1802	Z1802	1.7 mc	Same as above	0.12 ac rms
TP1803	Z1803	1.7 mc	Same as above	0.4 ac rms
TP1803	Z1803	Dc	Same as above	+260
TP1804	Z1804	1.7 mc	Same as above	0.3 ac rms
TP1805	Z1805	1.7 mc	Same as above	0.3 ac rms
TP1805	Z1805	Dc	Same as above	+260
TP1806	Z1806	1.7 mc	Same as above	0.3 ac rms
TP1807	Z1807	1.7 mc	Same as above	12 ac rms
TP1807	Z1807	Dc	Same as above	+230
TP1801	Twin-sideband input to V1801	300 kc	Same as above	0.2 ac rms
TP1808	Gain frequency bias	Dc	Same as above	−10
TP1809	Z1806 link	1.7 mc	Same as above	0.1 ac rms
TP1810	Agc bias	Dc	Same as above	−8
TP1812	Cathode V1802	Dc	Same as above	+0.5
TP1813	Cathode V1803	Dc	Same as above	+0.9
TP1814	Cathode V1804	Dc	Same as above	+2

h. Exciter-Monitor—Band 2 Mixer-Amplifier.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP1901	Z1901	2.3 mc	Band 2, 2.3000 mc, LEVEL controls on tsb modulator set to 0, agc bias R4513 set for 1 volt.	0.14 ac rms
TP1901	Z1901	Dc	Same as above	+260
TP1902	Z1902	2.3 mc	Same as above	0.12 ac rms
TP1903	Z1903	2.3 mc	Same as above	0.14 ac rms
TP1903	Z1903	Dc	Same as above	+260
TP1904	Z1904	2.3 mc	Same as above	0.16 ac rms
TP1905	Z1905	2.3 mc	Same as above	0.32 ac rms
TP1905	Z1905	Dc	Same as above	+260
TP1906	Z1906	2.3 mc	Same as above	0.3 ac rms
TP1907	Z1907	2.3 mc	Same as above	2.3 ac rms
TP1907	Z1907	Dc	Same as above	+230
TP801	Twin-sideband input to V1901	300 kc	Same as above	0.2 ac rms
TP1908	Gain frequency bias	Dc	Same as above	−10
TP1910	Agc network	Dc	Same as above	−8
TP1912	Cathode V1902	Dc	Same as above	+0.5
TP1913	Cathode V1903	Dc	Same as above	+0.9
TP1914	Cathode V1904	Dc	Same as above	+2

i. Exciter-Monitor—Band 3 Mixer-Amplifier.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP2001	Z2001	4.3 mc	Band 3, 4.3 mc, LEVEL controls on tsb modulator set to 0, agc bias R4513 set for 1 volt.	0.11 ac rms

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP2001	Z2001	Dc	Same as above	+260
TP2002	Z2002	4.3 mc	Same as above	0.12 ac rms
TP2003	Z2003	4.3 mc	Same as above	0.3 ac rms
TP2003	Z2003	Dc	Same as above	+240
TP2004	Z2004	4.3 mc	Same as above	0.3 ac rms
TP2005	Z2005	4.3 mc	Same as above	11 ac rms
TP2005	Z2005	Dc	Same as above	+230
TP2006	Gain frequency bias	Dc	Same as above	−5.3
TP2001	Twin-sideband input to V2001	1.7 mc	Same as above	0.06 ac rms
TP2012	Cathode V2002	Dc	Same as above	+1.8
TP2013	Cathode V2003	Dc	Same as above	+2

j. Exciter-Monitor—Band 4 Mixer-Amplifier.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP2101	Z2101	98.3 mc	Band 4, 8.3 mc, LEVEL controls on tsb modulator set to 0, agc bias R4513 set for 1 volt.	0.09 ac rms
TP2101	Z2101	Dc	Same as above	+230
TP2102	Z2102	8.3 mc	Same as above	0.1 ac rms
TP2103	Z2103	8.3 mc	Same as above	0.4 ac rms
TP2103	Z2103	Dc	Same as above	+240
TP2104	Z2104	8.3 mc	Same as above	0.3 ac rms
TP2105	Z2105	8.3 mc	Same as above	12 ac rms
TP2105	Z2105	Dc	Same as above	+230
TP2110	Gain frequency bias	Dc	Same as above	−2.3
TP2101	Twin-sideband input to V2101	2.3 mc	Same as above	0.06 ac rms
TP2112	Cathode V2102	Dc	Same as above	+2
TP2113	Cathode V2103	Dc	Same as above	+2

k. Exciter-Monitor—Band 5 Mixer-Amplifier.

Test point	Circuit being measured	Frequency	Condition of measurement	Normal reading (all readings in volts)
TP2201	Z2201	16.3 mc	Band 5, 16.3 mc, LEVEL controls on tsb modulator set to 0, agc bias R4513 set for 1 volt.	0.05 ac rms
TP2201	Z2201	16.3 mc	Same as above	+240
TP2202	Z2202	16.3 mc	Same as above	0.1 ac rms
TP2203	Z2203	16.3 mc	Same as above	0.3 ac rms
TP2203	Z2203	Dc	Same as above	+240
TP2204	Z2204	16.3 mc	Same as above	0.3 ac rms
TP2205	Z2205	16.3 mc	Same as above	10.5 ac rms
TP2205	Z2205	Dc	Same as above	+230
TP2210	Gain frequency bias	Dc	Same as above	+1.7
TP2201	Twin-sideband input to V2201	2.3 mc	Same as above	0.06 ac rms
TP2212	Cathode V2202	Dc	Same as above	+1.5
TP2213	Cathode V2203	Dc	Same as above	+2

CHAPTER 7

REPAIRS, ALINEMENT, AND LUBRICATION

Section I. REPAIRS

121. General

Most of the components in the modulator-oscillator are readily accessible and easily replaceable. Access to the various compartments may be obtained by following the procedures in paragraph 122. Certain subchassis in the exciter-monitor require special procedures for removal and replacement. These procedures are detailed in paragraph 122 through 124. Careless replacement of parts makes new faults inevitable. When replacing parts, observe the following precautions and techniques:

***Warning:* Before attempting any removal procedures, be sure that no power is applied to the modulator-oscillator.**

a. Before a part is unbolted or unsoldered, note the position of the leads. If the part has a number of connections, tag each of the leads to it.

b. Be careful not to damage other leads or components by pushing them out of the way.

c. Do not allow drops of solder to fall into the compartment or subchassis.

d. Make well-soldered joints. Do not disturb a solder connection in any way until the solder has cooled and solidified. Crystallized solder connections cause faulty operation that can be very difficult to trace.

e. When a part is replaced in any of the compartments, the new part must be placed in the exact position occupied by the old part. A new part that has the same electrical specifications but a different physical size may cause trouble in the RF circuits. Give particular attention to grounding. Use the same ground as the original wiring. Failure to observe these precautions may result in improper gain, regeneration, poor linearity, improper tracking, or oscillation.

f. While replacing a part, do not disturb the setting of any nearby variable components unless absolutely necessary. If a setting is disturbed, refer to the appropriate instructions for adjustment or alinement after the repairs have been completed.

122. Removal and Replacement of Compartments

(fig. 7, TM 11–5821–212–10)

Access to the various compartments may be gained by following the procedures listed. Before starting any removal procedures, press the FILAMENT OFF button to deenergize the equipment. Most of the repairs on the various compartments can be performed by sliding a compartment forward on the slide. Complete removal is necessary only if extensive repairs have to be performed on the compartment

a. Removal of Frequency Standard, Tsb Modulator, or Power Supply Compartment.

(1) Release the compartment locking screws on the handles.

(2) Grasp the handles and pull forward.

(3) Remove all connecting plugs to the compartment.

(4) Remove the screws that hold the compartment to the slides.

(5) Lift the compartment off the slides.

b. Replacement of Frequency Standard, Tsb Modulator, or Power Supply Compartment.

(1) Place the compartment on the slides.

(2) Replace the screws that hold the compartment to the slides.

(3) Replace all connecting plugs.

(4) Slide the compartment back into the case.

(5) Tighten the compartment locking screws.

c. Removal of Exciter-Monitor.

(1) Release the compartment locking screws on the handles.

(2) Pull the compartment forward and lock in the forward position by engaging the drawer latches.

(3) Remove the compartment top cover.

(4) Unlock the drawer locking pins (holding the chassis horizontal), and lift upward on the front of the drawer to position vertically. Relock the drawer pins in the vertical positioning holes.

(5) Remove the bottom cover.

Note. All repairs on the exciter-monitor can be performed with the compartment in this position. To remove the compartment completely, perform (6), (7), and (8) below.

(6) Remove all connecting plugs.

(7) Remove the screws that hold the compartment to the slides.

(8) Lift the compartment off the slides.

d. Replacement of Exciter-Monitor.

(1) Place the compartment in the slides.

(2) Replace the screws that hold the compartment to the slides:

(3) Replace all connecting plugs.

(4) Replace the bottom cover.

(5) Unlock the locking pins (hold the chassis vertically), and push downward on the front of the compartment to position horizontally. Relock the locking pins in the horizontal positioning holes.

(6) Replace the compartment top cover.

(7) Disengage the drawer latches and push the compartment back into the case.

(8) Tighten the compartment locking screws.

e. Removal of Automatic Line Voltage Control Panel.

(1) Release the four locking screws (two on each side) on the front panel.

(2) Grasp the handles and pull forward.

(3) Remove all connecting plugs.

(4) Remove the screws that hold the panel to the slides.

(5) Lift the assembly from the slides.

f. Replacement of Automatic Line Voltage Control Panel.

(1) Place the assembly on the slides.

(2) Replace the screws that hold the panel to the slides.

(3) Replace the connecting plugs.

(4) Slide the panel back into the case.

(5) Tighten the four locking screws.

g. Removal of Blower Filter Assembly.

(1) Release the eight locking screws (four on each side) on the front panel.

(2) Grasp the handles and pull forward.

(3) Remove all connecting plugs.

(4) Remove the screws that hold the compartment to the slides.

(5) Lift the compartment from the slides.

h. Replacement of Blower Filter Assembly.

(1) Place the compartment on the slides.

(2) Replace the screws that hold the compartment to the slides.

(3) Replace all connecting plugs.

(4) Push the compartment back into the case.

(5) Tighten the eight locking screws.

i. Removal of Power Supply Control Compartment.

(1) Release the four locking screws (two on each side) of the front panel.

(2) Pull the compartment forward.

(3) Remove all connecting plugs.

(4) Remove the screws that hold the compartment to the slides.

(5) Lift the compartment from the slides.

j. Replacement of Power Supply Control Compartment.

(1) Place the compartment on the slides.

(2) Replace the screws that hold the compartment to the slides.

(3) Replace all connecting plugs.

(4) Push the compartment back into the case.

(5) Tighten the four locking screws.

123. Removal and Replacement of Exciter-Monitor Subassemblies

During various steps in the procedures described in this paragraph, it may be necessary to change the slug rack drive mechanism adjustment on the subassemblies. Whenever this adjustment is changed, follow the procedures in paragraph 127*b* to readjust the shaft couplers.

a. Removal of Master Oscillator Subchassis (fig. 104).

(1) Set the band selector control to BAND 2.

(2) Set the FREQ-MC and FREQ-KC controls for a dial reading of 2.3000 mc.

(3) Disconnect plugs P1101, P811, and P833.

(4) Loosen the four mounting screws that hold the oscillator mounting frame to the main chassis.

(5) Carefully move the oscillator toward the rear of the compartment until the shaft coupler is disengaged. This requires about one-eighth inch total displacement.

(6) Remove the oscillator from the compartment. Do *not* disturb the position of the oscillator shaft except when necessary for repair operations.

b. Replacement of Master Oscillator Subchassis (fig. 104).

(1) Replace the oscillator in the compartment. Do not disturb the position of the oscillator shaft. If the coupler halves do not line up, rotate the oscillator shaft coupler half the minimum amount required to aline it with the mating coupler half before positioning the oscillator.

(2) Carefully move the oscillator toward the front of the drawer until the shaft coupler is engaged. This requires about one-eighth inch movement.

(3) Check the nylon worm adjustment screw to make sure it mates with the adjusting gear segment in approximately the middle of the gear range. Adjust as necessary.

(4) Tighten the four mounting screws that hold the oscillator mounting frame to the chassis.

(5) Connect plugs P1101, P811, and P833.

Resc C3

~~*Note.* If the position of the oscillator shaft has~~ been changed or if a new oscillator is being installed, allow the master oscillator to warm up with filaments on for at least 1 hour before ~~making frequency adjustments (par. 127c).~~

Sel C3 (6) (Added)

c. Removal of Interpolation Oscillator Subchassis (fig. 104).

(1) Set the band control to BAND 2.

(2) Set the FREQ-MC and FREQ-KC controls for a dial reading of 2.3000 mc.

(3) Disconnect plugs P812, P1002, and P1003.

(4) Loosen the four mounting screws that hold the interpolation oscillator mounting frame to the main chassis.

(5) Carefully move the oscillator toward the rear of the drawer until the shaft coupler is disengaged. This requires about one-eighth inch total displacement.

(6) Remove the oscillator from the compartment. Do not disturb the position of the oscillator shaft except when necessary for repair operations.

d. Replacement of Interpolation Oscillator Subchassis (fig. 104).

(1) Replace the oscillator in the compartment. Do not disturb the position of the oscillator shaft.

(2) Carefully move the oscillator toward the front of the drawer until the shaft coupler is engaged. This requires about one-eighth inch movement.

(3) Check the nylon worm adjustment screw to make sure it mates with the adjusting gear segment in approximately the middle of the gear range. Adjust as necessary.

(4) Tighten the four mounting screws that hold the oscillator mounting frame to the chassis.

(5) Replace plugs P812, P1002, and P1003.

Resc C3

~~*Note.* If the position of the oscillator shaft has~~ been changed, or if a new oscillator is being installed, turn the filaments on and allow the interpolation oscillator to warm up for at least 1 hour before making the frequency adjustments ~~(par. 127d).~~

(6) added

e. Removal of Smo Error Detector (fig. 104).

(1) Disconnect plugs P831, P1003, P809, P832, and P1101 from their corresponding jacks.

(2) Loosen the four mounting screws that hold the mounting frame to the main chassis.

(3) Remove the chassis from the compartment.

f. Replacement of Smo Error Detector (fig. 104).

(1) Return the chassis to the compartment.

(2) Tighten the four mounting screws that hold the mounting frame to the main chassis.

(3) Connect plugs P809, P831, P1003, P832, and P1101 to their corresponding jacks.

g. Removal of Phase Lock Indicator (fig. 104).

(1) Disconnect plug P865 from jack J4801.

(2) Loosen the four mounting screws that hold the phase lock indicator frame to the main chassis.

(3) Remove the phase lock indicator from the main chassis.

h. Replacement of Phase Lock Indicator (fig. 104).

(1) Replace the phase lock indicator subchassis in the main chassis.

(2) Tighten the four mounting screws to the main frame.

(3) Connect plug P865 to jack J4801.

i. Removal of Mixer-Amplifiers (fig. 103).

(1) Except for the different plugs and jacks that are to be disconnected, the removal procedures for all five mixer-amplifier subchassis (bands 1 through 5) are identical. The five sets of plugs and jacks to be disconnected are listed below:

(*a*) *Band 1 mixer-amplifier.* Jack J826-P1801, J825-P1802, J1801-P816, J1802, P850.

(*b*) *Band 2 mixer-amplifier.* Jack J828-P1901, J827-P1902, J1901-P817, J1902-P851.

(*c*) *Band 3 mixer-amplifier.* Jack J830-P2001, J829-P2002, J2001-P818, J2002-P852.

(*d*) *Band 4 mixer-amplifier.* Jack J832-P2101, J831-P2102, J2101-P819, J2102-P853.

(*e*) *Band 5 mixer-amplifier.* Jack J834-P2201, J833-P2202, J2201-P820, J2202-P854.

(2) Set the frequency controls on the exciter-monitor to the low-frequency end of the tuning range. (Band 1, 1.7 mc; band 2, 2.3 mc; band 3, 4.3 mc; band 4, 8.3 mc; and band 5, 16.3 mc.) This sets the slots in the couplers on the mixer-amplifier tuning shafts in a nearly vertical position.

(3) Disconnect the plugs and jacks ((1) above) for the mixer-amplifier being removed.

(4) Loosen the rear mounting screw and the two front mounting screws holding the subchassis to the main chassis.

Caution: **Do not handle the subchassis by its tuning shaft or slug rack.**

(5) Move the subchassis backward to disengage the coupler half. Lift the subchassis from the main chassis.

j. Replacement of Mixer-Amplifiers (fig. 103).

(1) Set the frequency control of the exciter-monitor to the low-frequency end of the tuning range of the mixer-amplifier being replaced.

(2) Turn the coupler half on the subchassis until the tuning slugs are fully inserted. Lower the mixer-amplifier subchassis into the main chassis. Rotate the flange of the subchassis coupler half clockwise about one-eighth turn so that the spline and the slot of the coupler halves are alined. Slide the subchassis forward to engage the coupler halves.

(3) Tighten the screws that secure the subchassis to the main chassis.

(4) Connect the plugs to the jacks (*i*(1) above).

(5) Refer to paragraphs 127*b* and 131*k* to check whether the mixer-amplifier requires adjustment or alinement.

k. Removal of Smo RF Subassembly (fig. 103).

(1) Operate the band switch to position 1.

(2) Operate the frequency controls of the exciter-monitor to obtain a dial indication of 1.7000 mc (band 1).

(3) Remove all coaxial connectors and power plug P821.

(4) Loosen the two mounting screws at the rear of the chassis and two mounting screws on the front positioning bracket.

Caution: **Do not use the slug racks for handling subassemblies.**

(5) Slide the subassembly toward the rear and lift it from the main chassis.

l. Replacement of Smo RF Subassembly (fig. 103).

(1) Set the frequency controls to obtain a dial reading of 1.7000 mc (band 1).

(2) Refer to figure 127. Turn the band switch shaft until the switch rotor contacts are positioned as shown.

(3) Position the subassembly in the main chassis. The subassembly band switch shaft coupler half should line up with the driver coupler half. If the coupler halves are misalined (as with a new subassembly), release the coupler clamp on the subassembly band switch shaft and turn the coupler half until it lines up with the driving coupler half. Tighten the clamp and recheck the switch positions as shown in figure 127. If the band switch alinement

has changed, release the coupler clamp, realine, and retighten the clamp, repeating the process until alinement is satisfactory.

(4) Slide the subassembly forward to engage the coupler halves. Refer to paragraph 127*b* for coupling adjustment. To secure the subassembly to the main frame, tighten the two mounting screws on the positioning bracket. Tighten the two screws at the rear of the chassis.

(5) Connect coaxial connectors P834 to J1521, P835 to J1522, P836 to J1523, P837 to J1524, P838 to J1525, P839 to J1526, P840 to J1527, and P841 to J1528. Connect power plug P821 to J1501.

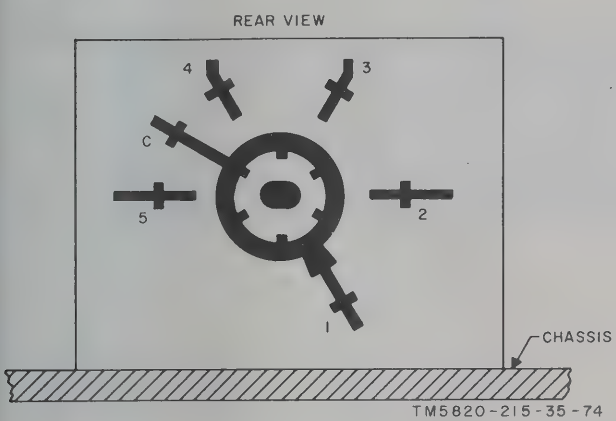


Figure 127. Smo RF band switch, band 1 position.

m. Removal and Replacement of Tuning Coils and Cores in Exciter-Monitor Subassembly. Observe the following steps when removing or replacing tuning coils or cores:

(1) The coil terminals are numbered clockwise (bottom view) corresponding to tube pin numbering. The offcenter holddown screw corresponds to an octal tube key.

(2) To remove the core, remove the two Phillips-head screws that secure the core mounting bracket to the slug rack.

(3) To remove the coil for inspection or for replacement, remove the core and insert a number 1 Phillips screwdriver into the center of the coil to engage the holddown screw. After the screw is loosened, rock the coil can slightly and pull upward to remove it from its socket. To remove the coil from the can, remove the two setscrews from the top of the can. Use care to prevent dropping screws into the subassembly chassis.

(4) When replacing a core after a coil has been mounted, be sure that the tuning rack is positioned closest to the coils, and that the core, lead screw, and connecting spring are straight before tightening the two Phillips screws that fasten the core mounting bracket to the slug rack.

n. Removal of Exciter-Monitor Front Panel (fig. 108).

(1) Remove plug P804 from J804; P804 and J804 are located behind the panel in the lower right-hand corner, viewed from the front.

(2) Remove the FREQ-MC, FREQ-KC, and BAND control knobs, locking keys, and knobs.

(3) Remove the panel mounting screws.

(4) Lift the panel forward carefully until the coaxial connectors on the monitor control assembly are exposed. Remove all five coaxial plugs from their corresponding jacks. Remove the panel.

o. Replacement of Exciter-Monitor Front Panel (fig. 108).

(1) Position the panel until all five plugs are close enough to be connected to the jacks.

(2) Connect the five coaxial plugs to their corresponding jacks. Replace the panel.

(3) Replace the panel mounting screws.

(4) Replace the FREQ-MC, FREQ-KC, and BAND control knobs, locking keys, and knobs.

(5) Connect P804 to J804.

p. Removal of Monitor Subchassis (fig. 104).

(1) Disconnect P1402 from J1402 and P859 from J1403. Jacks J1402 and J1403 are located on the forward edge of the subchassis, close to the main chassis.

(2) Remove power plug P810 from J1401. Remove P1401, P861, and P862 from J1413, J1406, and J1407.

(3) Release the four mounting screws holding the chassis in place. Remove the subchassis.

q. Replacement of Monitor Subchassis (fig. 104).

(1) Position the monitor subchassis on the main frame. Tighten the four mounting

screws holding the subchassis in place.

(2) Connect power plug P810 to J1401. Connect P1401, J861, and P862 to J1413, J1406, and J1407.

(3) Connect P1402 to J1402 and P859 to J1403.

r. Removal of Band Switch Subchassis (fig. 103).

(1) Set the BAND control to band 1.

(2) Remove power plug P822 from J4401. Remove P844, P843, P845, P847, P842, and P846 from their corresponding jacks.

(3) Release the three mounting screws. Slide the chassis back and lift it out.

s. Replacement of Band Switch Subchassis (fig. 103).

(1) Remove the four screws holding the cover plate to the side of the chassis.

(2) Refer to figure 128. Rotate the band switch shaft manually until the switch rotor contacts are positioned as shown. Replace the cover plate.

(3) Set the BAND control to band 1.

(4) Position the band switch subchassis in the main chassis. The band switch coupler half should line up with the driving coupler half. If the coupler halves are misalined (as with a new subchassis), release the coupler clamp on the subchassis band switch shaft, and turn the coupler half until it lines up with the driving coupler half. Tighten the coupler clamp, remove the cover plate, and recheck the switch rotor contacts as shown in figure 128. If necessary, release the coupler clamp, and realine the switch rotor contacts until the position is correct. Tighten the coupler clamp (par. 127*b*).

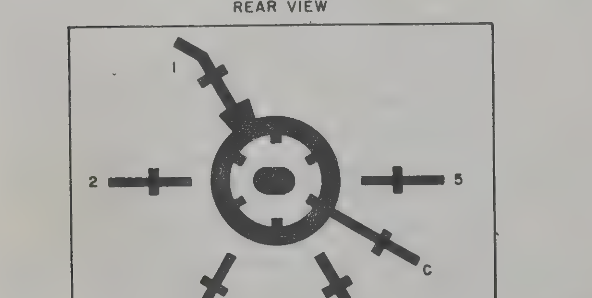


Figure 128. Band switch, in band 1 position.

t. Removal of 0.5-Kc Spectrum Detent Subchassis (fig. 103).

(1) Disconnect six coaxial plugs P826, P1002, P829, P830, P828, and P827 from their corresponding jacks. Remove power plug P808 from J1207.

(2) Disconnect P812 from J1001; J1001 is located at the rear of the interpolation oscillator mounting frame (fig. 104).

(3) Release the six screws holding the 0.5-kc spectrum detent subchassis in the plate. Remove the subchassis, rotating as necessary to clear adjacent nuts.

u. Replacement of 0.5-Kc Spectrum Detent Subchassis (fig. 104).

(1) Turn the FREQ-KC dial to 000 (example: 1.7000 on band 1).

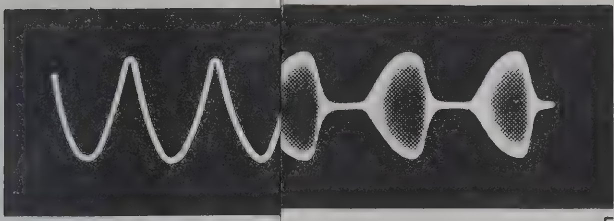
(2) Install the subchassis on the main chassis, and secure the six mounting screws. The chassis must be turned and guided into position between adjacent units.

(3) Manually adjust the slug rack on top of the Z1201 assembly until it reaches the top of its travel. Turn the slug rack coupler clockwise until it mates with the coupler connected to the gear train.

(4) See that the FREQ-KC dial is set to 000. Engage the coupler halves, and tighten the coupler clamp (par. 127*b*). Adjust as necessary.

(5) Turn the FREQ-KC dial slowly through its entire range, watching the slug rack on Z1201 to make sure that it does not hit the rack end stops before the automatic tuning stops are reached. The dial automatic tuning stops should occur at least one-quarter of a turn of the FREQ-KC knob beyond either end of the numerical dial travel (000 to 999). If the rack stop points are reached before the automatic tuning stops, the rack adjustment is incorrect. Check the position of the mating coupler connected to the gear train, and if its splines are not at 90° to the chassis mounting surface, adjust to this position.

(6) Connect all coaxial plugs to their corresponding jacks; P826 to J1201, P1002,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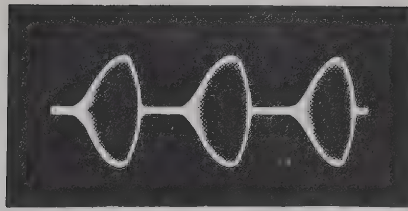
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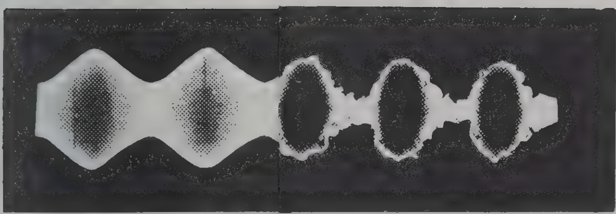
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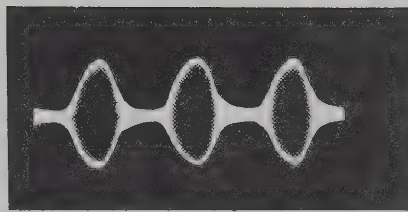
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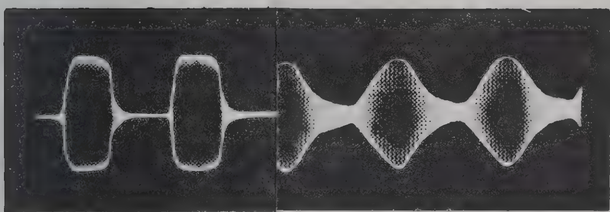
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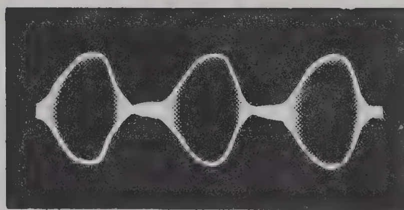
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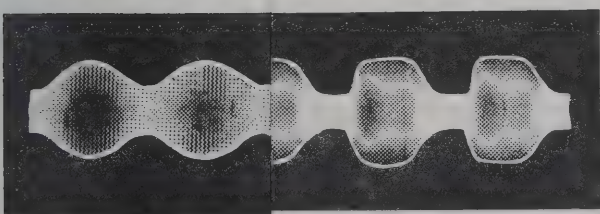
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screws holding the subchassis in place.

(2) Connect power plug P810 to J1401. Connect P1401, J861, and P862 to J1413, J1406, and J1407.

(3) Connect P1402 to J1402 and P859 to J1403.

r. Removal of Band Switch Subchassis (fig. 103).

(1) Set the BAND control to band 1.

(2) Remove power plug P822 from J4401. Remove P844, P843, P845, P847, P842, and P846 from their corresponding jacks.

(3) Release the three mounting screws. Slide the chassis back and lift it out.

s. Replacement of Band Switch Subchassis (fig. 103).

(1) Remove the four screws holding the cover plate to the side of the chassis.

(2) Refer to figure 128. Rotate the band switch shaft manually until the switch rotor contacts are positioned as shown. Replace the cover plate.

(3) Set the BAND control to band 1.

(4) Position the band switch subchassis in the main chassis. The band switch coupler half should line up with the driving coupler half. If the coupler halves are misalined (as with a new subchassis), release the coupler clamp on the subchassis band switch shaft, and turn the coupler half until it lines up with the driving coupler half. Tighten the coupler clamp, remove the cover plate, and recheck the switch rotor contacts as shown in figure 128. If necessary, release the coupler clamp, and realine the switch rotor contacts until the position is correct. Tighten the coupler clamp (par. 127*b*).

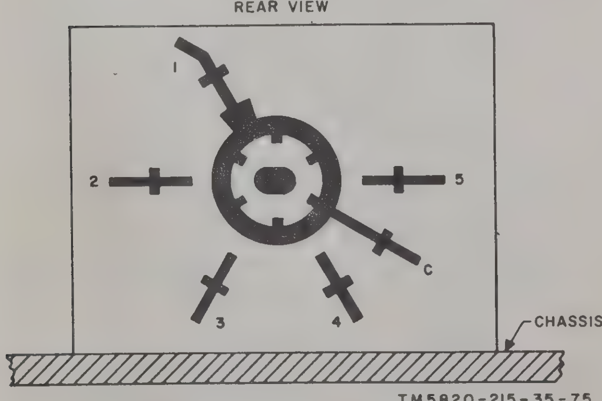

Figure 128. Band switch, in band 1 position.

t. Removal of 0.5-Kc Spectrum Detent Subchassis (fig. 103).

(1) Disconnect six coaxial plugs P826, P1002, P829, P830, P828, and P827 from their corresponding jacks. Remove power plug P808 from J1207.

(2) Disconnect P812 from J1001; J1001 is located at the rear of the interpolation oscillator mounting frame (fig. 104).

(3) Release the six screws holding the 0.5-kc spectrum detent subchassis in the plate. Remove the subchassis, rotating as necessary to clear adjacent nuts.

u. Replacement of 0.5-Kc Spectrum Detent Subchassis (fig. 104).

(1) Turn the FREQ-KC dial to 000 (example: 1.7000 on band 1).

(2) Install the subchassis on the main chassis, and secure the six mounting screws. The chassis must be turned and guided into position between adjacent units.

(3) Manually adjust the slug rack on top of the Z1201 assembly until it reaches the top of its travel. Turn the slug rack coupler clockwise until it mates with the coupler connected to the gear train.

(4) See that the FREQ-KC dial is set to 000. Engage the coupler halves, and tighten the coupler clamp (par. 127*b*). Adjust as necessary.

(5) Turn the FREQ-KC dial slowly through its entire range, watching the slug rack on Z1201 to make sure that it does not hit the rack end stops before the automatic tuning stops are reached. The dial automatic tuning stops should occur at least one-quarter of a turn of the FREQ-KC knob beyond either end of the numerical dial travel (000 to 999). If the rack stop points are reached before the automatic tuning stops, the rack adjustment is incorrect. Check the position of the mating coupler connected to the gear train, and if its splines are not at 90° to the chassis mounting surface, adjust to this position.

(6) Connect all coaxial plugs to their corresponding jacks; P826 to J1201, P1002,

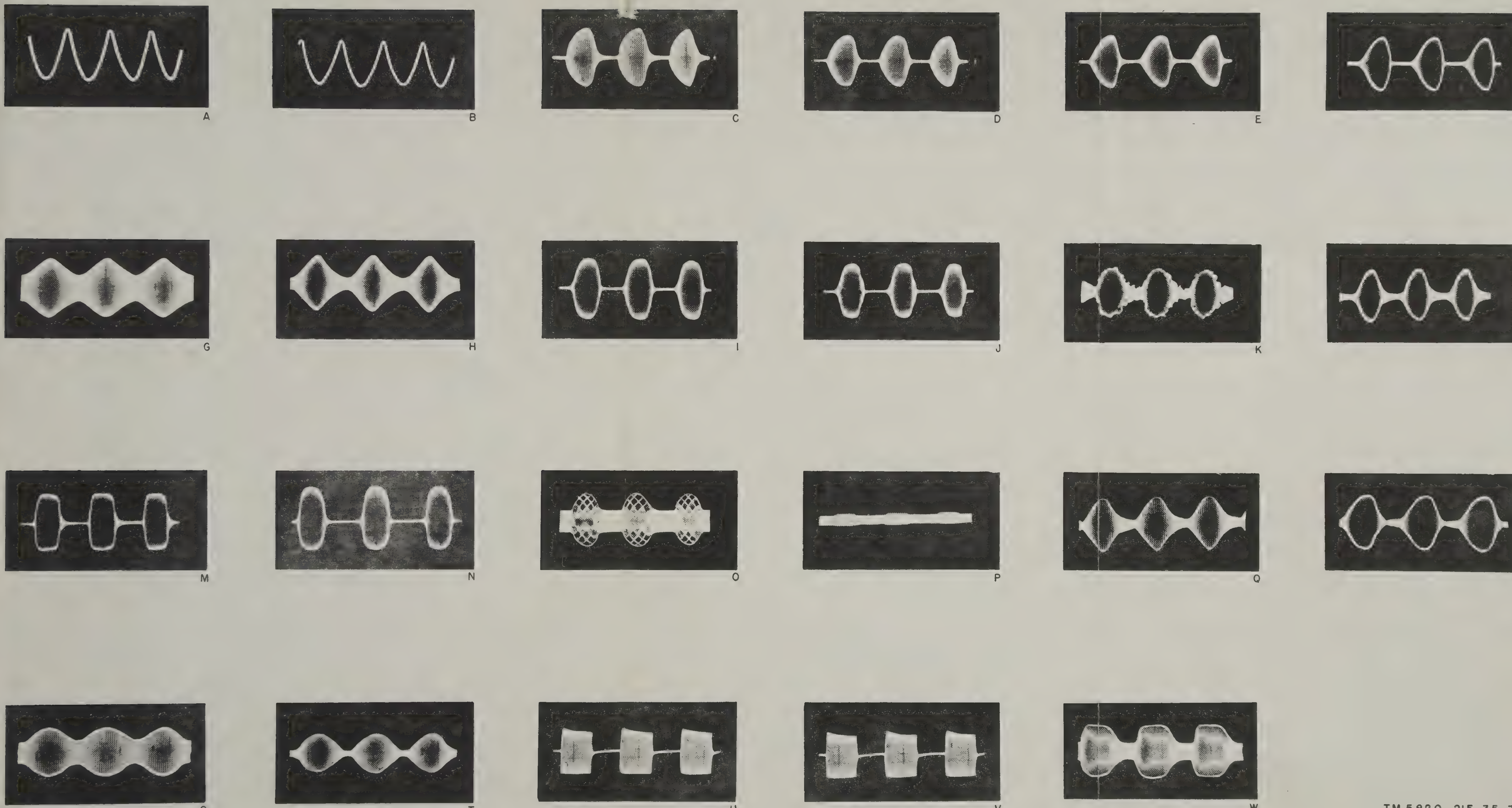

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Figure 126. Test point wave shapes.

J1202, P829 to J1205, P830 to J1206, J828 to J1204, and P827 to J1203. Connect power plug J808 to J1207. Jack and plug combinations are identified on the tags fastened to the cables adjacent to the plugs.

(7) Replace P812 in J1001.

(8) Refer to paragraph 131*j*, and aline the entire subchassis.

v. Removal of Gain-Frequency Potentiometer R803 or R810 (fig. 108).

(1) Remove the front panel (*n* above).

(2) Remove the four screws holding the potentiometer bracket to the main gear panel. Remove the bracket.

(3) Release the gear clamp on the potentiometer being removed. Remove the gear.

(4) Release the potentiometer panel nut. Remove the nut, lockwasher, and potentiometer. Unsolder all external leads from the potentiometer terminals.

w. Replacement of Gain-Frequency Potentiometer R803 or R810 (fig. 108).

(1) Install new shunting resistors on the replacement potentiometer, using the old assembly as a guide. Use 1 percent tolerance resistors. Be careful in soldering to avoid overheating the resistors.

(2) Solder the external leads to the potentiometer terminals. Replace the potentiometer, lockwasher, and nut.

(3) To position the bracket on the main gear panel, slide the bracket into position so that the gears mesh properly before tightening the mounting screws. Refer to paragraph 128*b* and synchronize the potentiometers in the gear train.

(4) Replace the front panel (*o* above).

124. Removal and Replacement of Exciter-Monitor Mechanical Units

a. Removal of Frequency-MC or Frequency-KC Positioning Head (fig. 108).

(1) Set the FREQ-MC and FREQ-KC controls for a dial reading of 1.7000 mc (band 1).

(2) Remove the front panel (par. 123*n*).

(3) Loosen the shaft clamp on the head output shaft. The head output shaft extends from the rear of the assembly through the subpanel.

(4) Remove the three mounting screws holding the positioning head to the panel. Remove the head.

b. Replacement of Frequency-MC or Frequency-KC Positioning Head (fig. 108).

(1) See that the dials are set to 1.7000 mc before replacing the head.

(2) Mount the head with the three mounting screws, position the output shaft in the main drive shaft, and mesh the automatic tuning gear (on top of the positioning head) with its mating gear on the main train. Do not tighten the output shaft clamp. Install the knob temporarily in place.

(3) Turn the input shaft (extending from the front of the positioning head) fully counterclockwise to the stop.

(4) Turn the input shaft ¼ turn (90°) clockwise.

(5) See that the frequency dials read 1.7000 mc (band 1), and tighten the output shaft clamp (par. 127*b*).

(6) Synchronize the positioning head (par. 128*a*).

(7) Replace the front panel (par. 123*o*).

c. Removal of Band Switch Positioning Head (fig. 108).

(1) Set the FREG-MC and FREQ-KC controls for a dial reading of 1.7000 mc.

(2) Remove the front panel (par. 123*n*).

(3) Loosen the dial mask cord clamp on the control shaft. Remove the cord from the pulley.

(4) Remove the two screws holding the dial mask guide pulley bracket. Remove the dial mask spring, and slip the mask free.

(5) Remove the three mounting screws holding the positioning head in place.

(6) Remove the head.

d. Replacement of Band Switch Positioning Head (fig. 108).

(1) Place the output coupler half and clamp on the output shaft extending from the rear of the head. Do not tighten the clamp.

(2) Mount the head in place with the three mounting screws, engaging the automatic

tuning drive gear as the head is positioned. Replace the BAND control knob on the shaft.

(3) Rotate the knob fully counterclockwise to the stop. Rotate the knob $\frac{1}{16}$ turn clockwise.

(4) Engage the coupler halves at the rear of the head. Tighten the coupler clamp (par. 127*b*).

(5) Turn the BAND control knob fully clockwise to the stop. Rotate counterclockwise to the first detent (this should require approximately $\frac{1}{16}$ turn). Slip the dial mask into place on the two upper guide pulleys, and fasten the dial mask spring in position. Slip the lower guide pulley into the lower dial mask slot, and mount the pulley bracket on the front of the head. Remove the knob from the band switch shaft. Install the dial mask cord pulley on the input shaft. Do not tighten the pulley clamp.

(6) Wind the dial mask cord 1 full turn clockwise around the pulley and slip the cord end through the pulley clamp jaws. Hold the cord against the jaws and turn the pulley until the dial mask slot is positioned over the last two FREQ-MC counter wheels, showing a dial reading of 16.3000 mc. Tighten the pulley clamp.

(7) Rotate the BAND control counterclockwise through the other detents, checking to see that the mask slot lines up on the low-frequency end of each band as successive detents are reached (16.3, 8.3, 4.3, 2.3, and 1.7 mc). If the mask slot does not center accurately on all bands, loosen the pulley clamp, readjust as necessary, and retighten.

(8) Synchronize the head in the automatic tuning system (par. 128*a*).

(9) Replace the front panel (par. 123*o*).

e. Removal of Automatic Tuning Control Head (fig. 108).

(1) Remove the front panel (par. 123*n*).

(2) Remove the control head plug from J805.

(3) Remove the cable clamp. Remove the mounting screws holding the head in place.

(4) Remove the head.

f. Replacement of Automatic Tuning Control Head (fig. 108).

(1) Mount the head with the three mounting screws, engaging the drive gear as the head is positioned.

(2) Connect the plug from the control head to jack J805. Install the cable clamp.

(3) Synchronize the automatic tuning system (par. 128*a*).

(4) Replace the front panel (par. 123*o*).

g. Removal of Mechanical Interpolator Unit (figs. 104, 129, and 130).

Note. Do not attempt removal of the mechanical interpolator unit unless a replacement unit is available. Do not attempt to repair a defective unit. If any part is damaged or otherwise defective, remove the entire unit and replace it with a new one.

(1) Rotate the BAND, FREQ-MC, and FREQ-KC controls for a dial reading of 16.3000 (band 5).

(2) Remove the front panel (par. 123*n*).

(3) Replace the FREQ-MC, FREQ-KC, and BAND control knobs. With the dial reading remaining at 16.3000 mc, lock the FREQ-MC, FREQ-KC, and control knob wingnuts. Tilt the compartment up into the vertical position and lock in place.

(4) Remove plug P813 (fig. 104) from jack J813. Remove the 0.5-kc spectrum detent subchassis (par. 123*t*) and the stabilized master oscillator subassembly (par. 123*a*).

(5) For this step and (6) and (7) below, refer to figure 129. Rotate the BAND control knob through successive detents until the setscrew on the band switch shaft coupler clamp (rear coupler half) is accessible. Release the setscrew just enough to permit the associated coupler half to slide along the shaft. Do not release the screw so far that the clamp will rotate freely. While holding the coupler clamp so that the setscrew remains accessible, rotate the BAND control back to band 5. Lock the wingnut on the BAND control knob.

(6) At this point, the coupler half released in (5) above must be wedged against the mating coupler half to prevent loss of the associated band switch drive belt when the mechanical interpolator unit is removed. Proceed as follows:

(*a*) Obtain two wedges with dimensions such that they will slip between the main gear panel and the released coupler half.

(b) Slip the wedges into the positions indicated in figure 129. Press them far enough to wedge the coupler halves firmly together. Do not disturb the position of the coupler clamp, as the setscrew must remain accessible.

(7) Release the wingnut on the FREQ-MC control knob. Rotate the control until the clamp setscrews on the two FREQ-MC interpolator coupling gears are accessible. Release the setscrews. Reset the FREQ-MC control for a dial reading of 16.3000 mc. Lock the wingnut.

(8) Refer to figure 130. Release the wingnut on the FREQ-KC control knob. Rotate the control until the clamp setscrews on the large FREQ-KC shaft-to-interpolator coupling gear is accessible. Release the setscrew and remove the gear. Reset the FREQ-KC control for a dial reading of 16.3000 mc. Lock the wingnut on the FREQ-KC control knob.

(9) Refer to figure 130. Release the three mechanical interpolator mounting screws. While releasing the final screw, hold the unit against the panel so that it does not drop out of position.

Note. One of these screws is a critical length (fig. 130) and must be installed in its original position when the replacement unit is installed.

(10) Carefully work the unit free of the panel. Do not force it in any way because this could damage the associated components. If the wedges ((6) above) loosen when the unit is partially withdrawn, reposition the unit, force the wedges tightly into place, then withdraw the unit. Lift the unit free of the main frame.

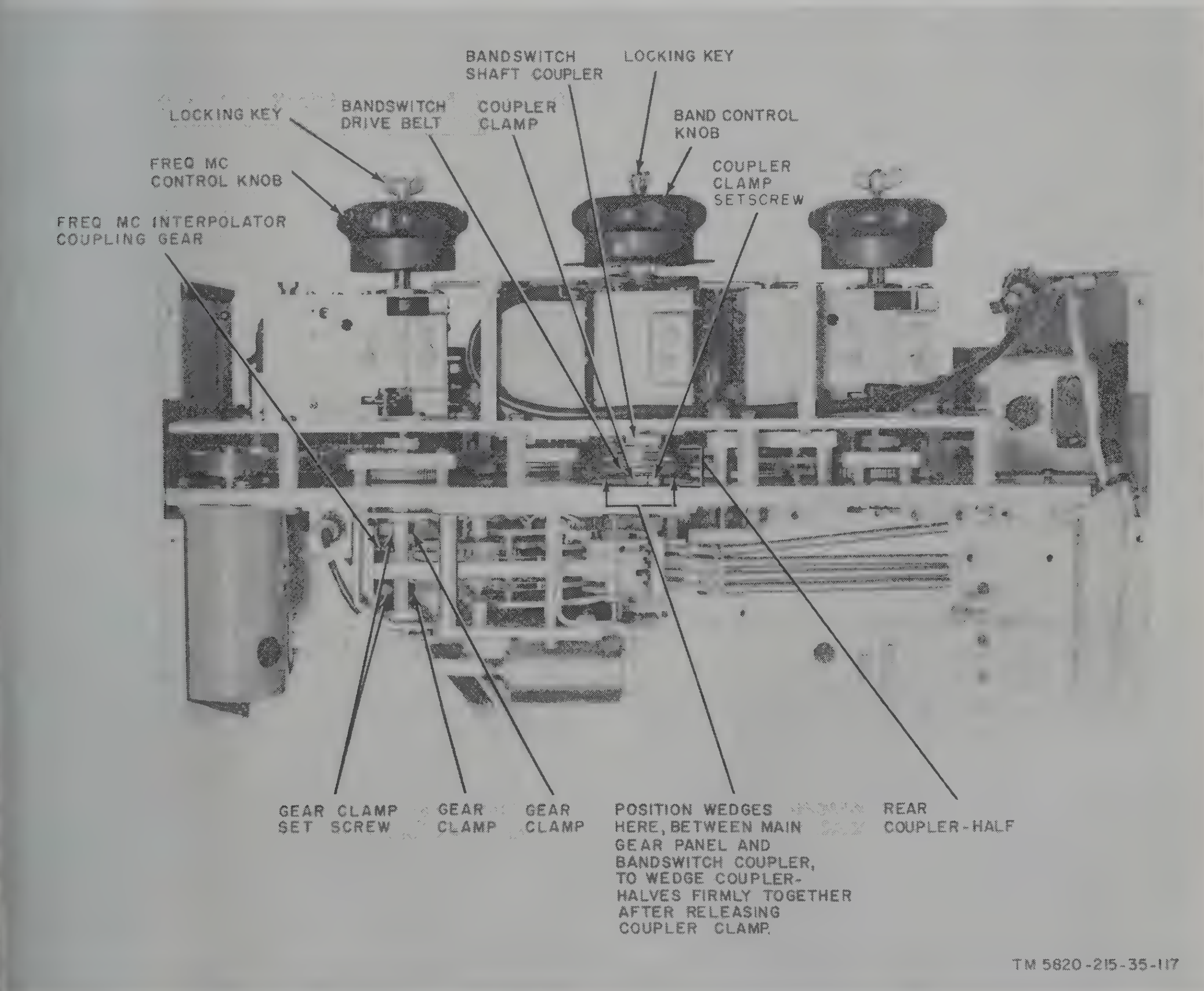


Figure 129. Mechanical interpolator removal, location of components, top view.

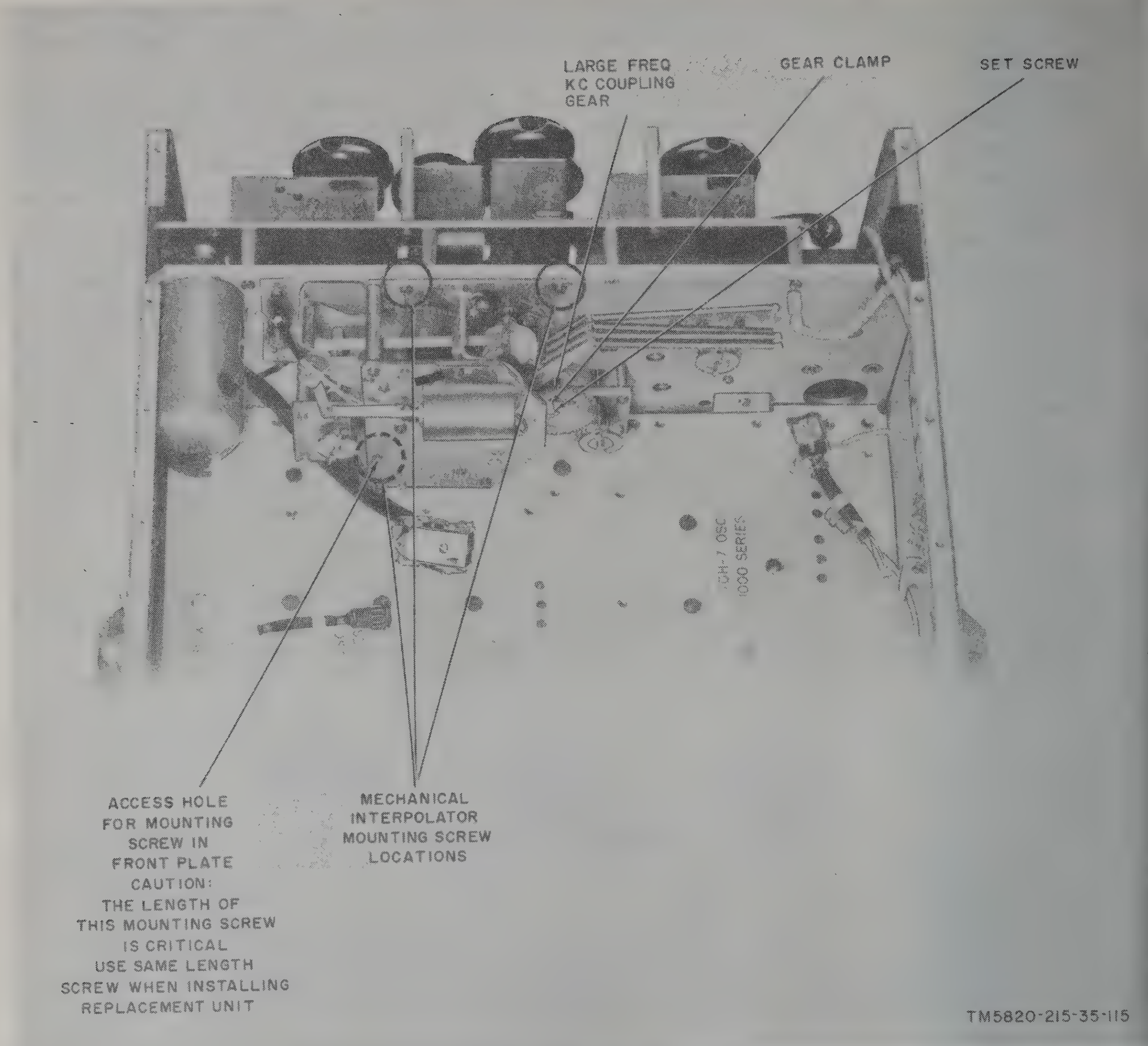


Figure 130. Mechanical interpolator removal, location of components, rear view.

h. Installation of Mechanical Interpolator Unit (figs. 104 and 131 through 134).

Note. Replacement mechanical interpolator units are partially presynchronized at the factory. The units are locked to preserve this synchronization. The locking components are tagged on the replacement units. Do not remove the tag or the locking components until instructed to do so in the installation procedure below.

(1) Refer to figure 131. Note that the number one pawl is in the home position, with the other three pawls retracted. This corresponds to a band switch setting on either band 1 or band 2. The band setting must be established on band 5 before the unit is installed. To establish this setting, rotate the band switch shaft on the replacement unit clockwise through the various detents until the number four pawl drops into the home position. At this setting, pawls one, two, and three will be retracted.

(2) If the replacement unit is equipped with a band switch shaft coupler, release the coupler clamp setscrew, and remove the coupler and clamp from the band switch shaft.

(3) Refer to figure 131. Note the forward and rear pairs of nylon detent wheels. With the

number four pawl in the home position, corresponding to band 5, the forward pair of detent wheels is locked, while the rear pair is free to rotate. On the replacement unit, rotate the rear pair of detent wheels manually until four detent notches are alined (as shown on the figure), two on the forward (locked) pair and two on the rear (free) pair. The unit is now ready to be installed in the exciter-monitor.

(4) Refer to figure 132. Replace the new unit as follows:

(*a*) Place the replacement interpolator unit behind the panel with the band switch coupling shaft lined up with the wedged coupler (*g*(6) above).

(*b*) Slide the large FREQ-MC shaft-to-interpolator coupling gear along the gear shaft until it lines up between the two forward nylon detent wheels. Slide the small FREQ-MC shaft-to-interpolator coupling gear along the gear shaft until it lines up between the two rear nylon detent wheels. It may be necessary to twist the replacement unit away from the gear shaft to position the gears between the detent wheels.

(*c*) Mesh the two FREQ-MC shaft coupling gears with the mating gears between the pairs of detent wheels. Slide the replacement unit toward the panel, inserting the band switch shaft into the wedged coupler. Slide the FREQ-MC coupling gears along the gear shaft as the unit is positioned, keeping them meshed with the mating gears between the detent wheels.

(*d*) Press the replacement unit against the panel, and aline the mounting screw holes in the unit front plate with the threaded holes at the rear of the main exciter-monitor gear panel. Install the mounting screws just far enough to hold the unit in position (fig. 130). Do not tighten the mounting screws further at this time.

(5) Refer to figures 133 and 134. Line up the large FREQ-KC coupling gear with the FREQ-KC coupling shaft. Slip the gear on the shaft just far enough to mesh the forward gear face, but not far enough to mesh the rear gear face. Spring-load the gear by rotating the gear face through at least three teeth. Slide the gear forward on the shaft, and mesh both faces with the mating gear on the FREQ-KC drive shaft while maintaining the gear loading. Do not tighten the gear clamp.

(6) Change the position of the replacement interpolator unit slightly as necessary to establish sufficient meshing pressure against to FREQ-MC coupling gears (fig. 132) to eliminate backlash without binding. Tighten the mounting screws.

(7) Check to make sure that none of the coupling gears are meshed tight enough to bind or loose enough to lose mesh. If mesh is incorrect, loosen the mounting screws and repeat (6) above.

(8) See that the number four pawl is in position as described in (1) above. Slide the large FREQ-MC coupling gear (fig. 132) along the gear shaft until it is positioned midway between the forward pair of nylon detent wheels. Tighten the gear clamp.

(9) Remove the two wedges from the band switch shaft coupler. Tighten the coupler clamp (par. 127*b*).

(10) Refer to (3) above, and check the position of the rear pair of nylon detent wheels. If the four notches (two in the forward pair and two in the rear pair of detent wheels) have become misalined during installation, realine them as shown in figure 131.

(11) Release the wingnut on the BAND control knob. Turn the control to band 4. This will cause the number two pawl (fig. 131) to drop into the home position, locking the rear pair of detent wheels.

(12) Slide the small FREQ-MC coupling gear (fig. 132) along the gear shaft until it is positioned bidway between the rear pair of nylon detent wheels. Tighten the gear clamp.

(13) Remove the synchronization locking components installed at the factory. These components are tagged and were installed to preserve synchronization of the replacement unit.

(14) At this point in the installation, the replacement unit must be precisely synchronized with the rest of the gear train. This

synchronization procedure is described in (15), (16), and (17) below.

(15) Release the wingnut on the FREQ-MC control knob.

(16) Grasp the FREQ-MC control knob. Rotate the BAND control knob slowly through positions 2, 3, 4, and 5. If the unit is not precisely synchronized, the FREQ-MC knob will move slightly with a sharp, twisting motion as some or all of the successive detents are reached. If no motion is felt, proceed to (18) below. If motion is felt, proceed with (17) below.

Note. A slight jar of the FREQ-MC knob will be felt as the band switch detents are reached. Do not confuse this jar with the sharp twisting motion indicative of improper synchronization.

(17) Refer to figures 132, 133, and 134. Final synchronization is performed by turning the small FREQ-KC coupling gear manually through small increments, rechecking synchronization as explained in (16) above after each incremental adjustment. Proceed as follows:

(*a*) Rotate the small FREQ-MC coupling gear in either direction by not more than one or two teeth (10 or 15°).

(*b*) Repeat (16) above. Note whether the movement of the FREQ-MC knob has increased or decreased as a result of the adjustment in (*a*) above. Be sure to rotate the BAND control knob through all the positions (2, 3, 4, and 5) regardless of the position or positions where movement was previously detected.

(*c*) If the movement felt when (16) above was repeated was greater than that felt before the small FREQ-KC coupling gear was adjusted in (*a*) above, the gear was adjusted in the wrong direction. If the movement felt after adjustment was less than that felt previously, the direction of rotation of the gear was correct. Repeat (*a*) and (*b*) above, rotating the small FREQ-KC gear in the direction that will result in a reduction of the amount of motion when (16) above is repeated.

(*d*) Continue (*a*), (*b*), and (*c*) above until no motion is detected when (16) above is repeated.

(18) Tighten the gear clamp on the large FREQ-KC coupling gear.

(19) Release the wingnut on the FREQ-KC control knob. Refer to figure 132. Slowly rotate the FREQ-KC control through its entire range (including overtravel) while observing the pawl followers that ride under the pawls. As the upper end of the FREQ-KC range is approached (999 plus overtravel), the pawl followers will ride toward the end of the pawl. If the final synchronization procedure has not been performed exactly as indicated, or if the factory synchronization was partially lost during shipment or installation, the pawl followers may spring free of the pawls before the high-frequency end of the FREQ-KC range is reached. If this occurs the entire synchronization is lost, and the unit must be removed and replaced with an entirely new unit. If the pawl followers do not spring free at any point during the entire FREQ-KC range (including overtravel), the synchronization is complete.

(20) Replace the master oscillator subassembly (par. 123*b*), the error detector subchassis (par. 123*f*), and the 0.5-kc spectrum detent subchassis (par. 123*u*).

(21) Connect plug P813 to jack J813.

(22) Set the exciter-monitor compartment in the horizontal position on the slides and lock in place.

(23) Replace the front panel (par. 123*o*).

i. Removal of 0.5-Kc Microswitch S805 (fig. 108).

(1) Remove the front panel (par. 123*n*).

(2) Remove plug P807 from jack J807.

(3) Remove the two screws and nuts holding the switch in place. Remove the switch and actuating lever. Unsolder the wires from the switch terminals (NO and C).

j. Replacement of 0.5-Kc Microswitch S805 (fig. 108).

(1) Solder the wire to the NO and C terminals of the new switch. Replace the switch and actuating lever. Replace the two screwnuts that hold the switch in place.

(2) Connect P807 to J807.

(3) Synchronize the switch assembly as described in paragraph 128*c*.

(4) Replace the front panel (par. 123*o*).

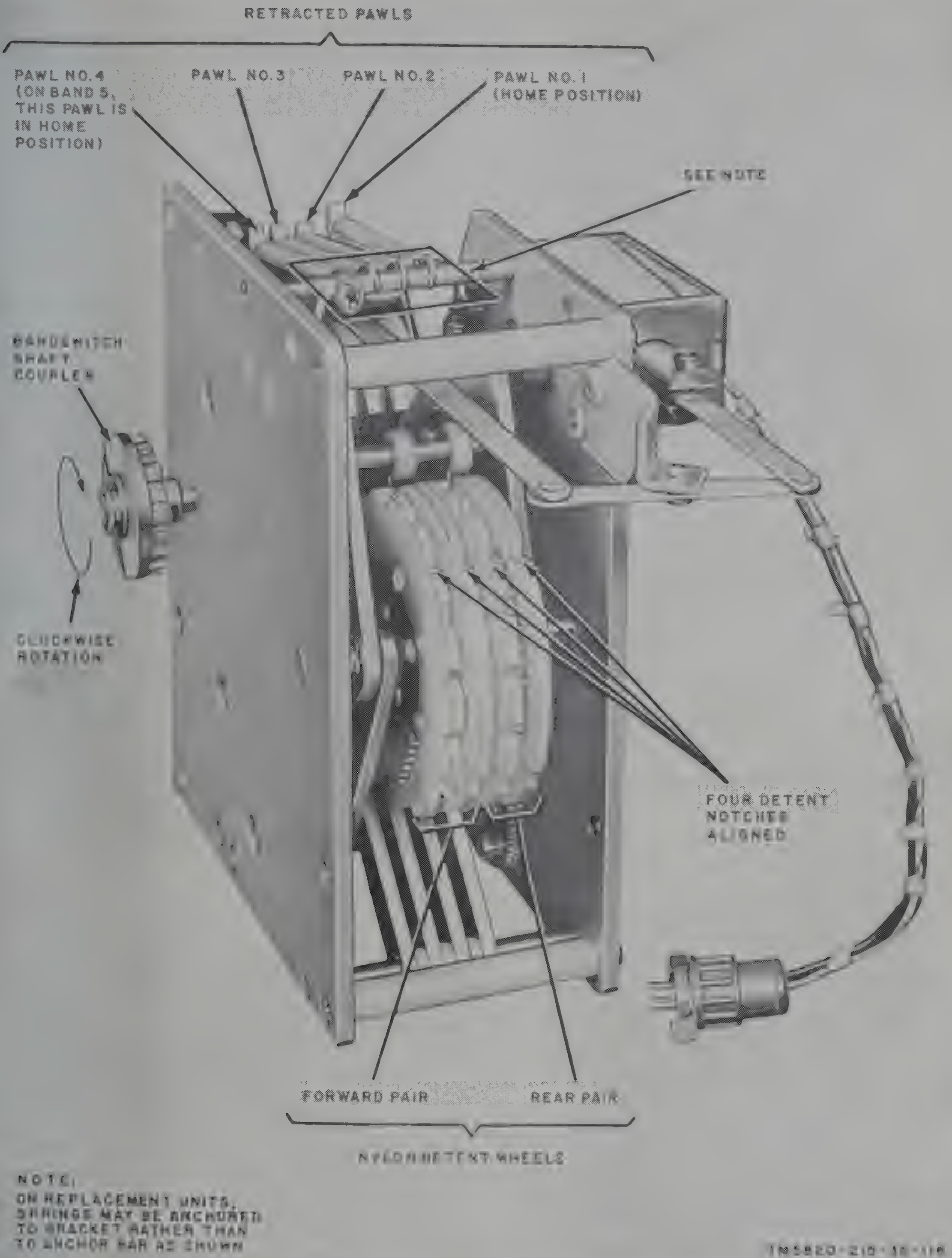


Figure 131. Mechanical interpolator installation, pawl position and detent wheel setup.

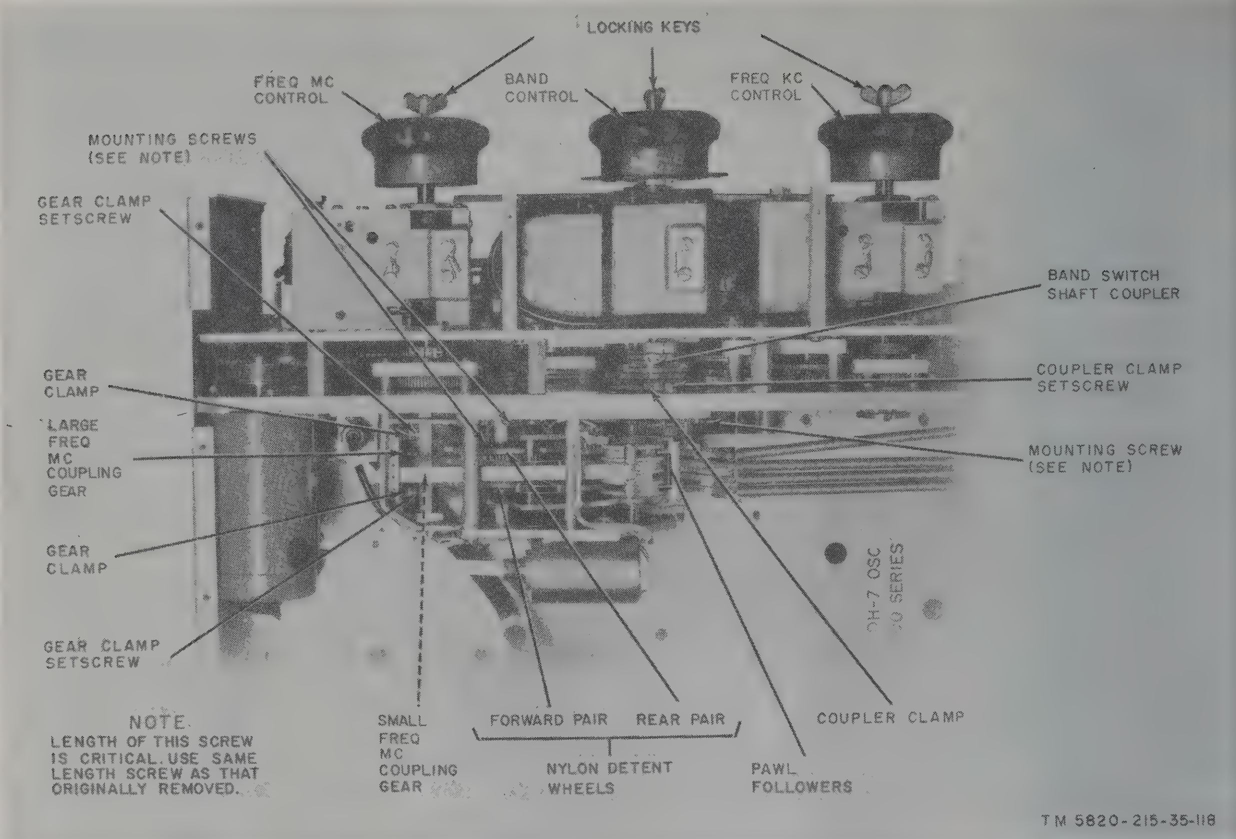


Figure 132. Mechanical interpolator installation, location of components.

k. Removal of Frequency Counter Dial Assembly (fig. 108).

(1) Remove the front panel (par. 123*n*). Replace the control knobs.

(2) Rotate the FREQ-MC, FREQ-KC, and BAND controls to obtain a dial reading of 16.3000 mc (band 5).

(3) Release the mask cord pulley clamp. Remove the mask cord from the pulley.

(4) Remove the two screws holding the lower mask positioning pulley bracket to the band switch head. Remove the bracket.

(5) Remove the dial mask spring located at the top of the mask. Slip the dial mask free of the upper positioning pulleys and remove it.

(6) Remove the four screws holding the frequency counter dial assembly to the main gear panel. Lift the assembly straight forward and remove.

l. Replacement of Frequency Counter Dial Assembly (fig. 108).

(1) Position the assembly over the four mounting studs, rotating the counter dial driv gears slightly as necessary to engage them Disregard the actual positions of th counter dials. Secure the four mountin screws in place.

(2) Refer to paragraph 128*d* and synchroniz the counter dials.

(3) Turn the BAND control knob fully clock wise to the stop. Rotate counterclockwis to the first detent (this should require ap proximately 21° rotation). Slip the dia mask into place on the two upper guid pulleys, and fasten the dial mask spring i position. Slip the lower guide pulley int the mask slot, and mount the pulle bracket on the front of the band switc head. Remove the knob from the ban switch shaft. Install the dial mask cor pulley on the input shaft. Do not tighte the pulley clamp.

(4) Wind the dial mask cord 1 full turn clock wise around the pulley, and slip the cor

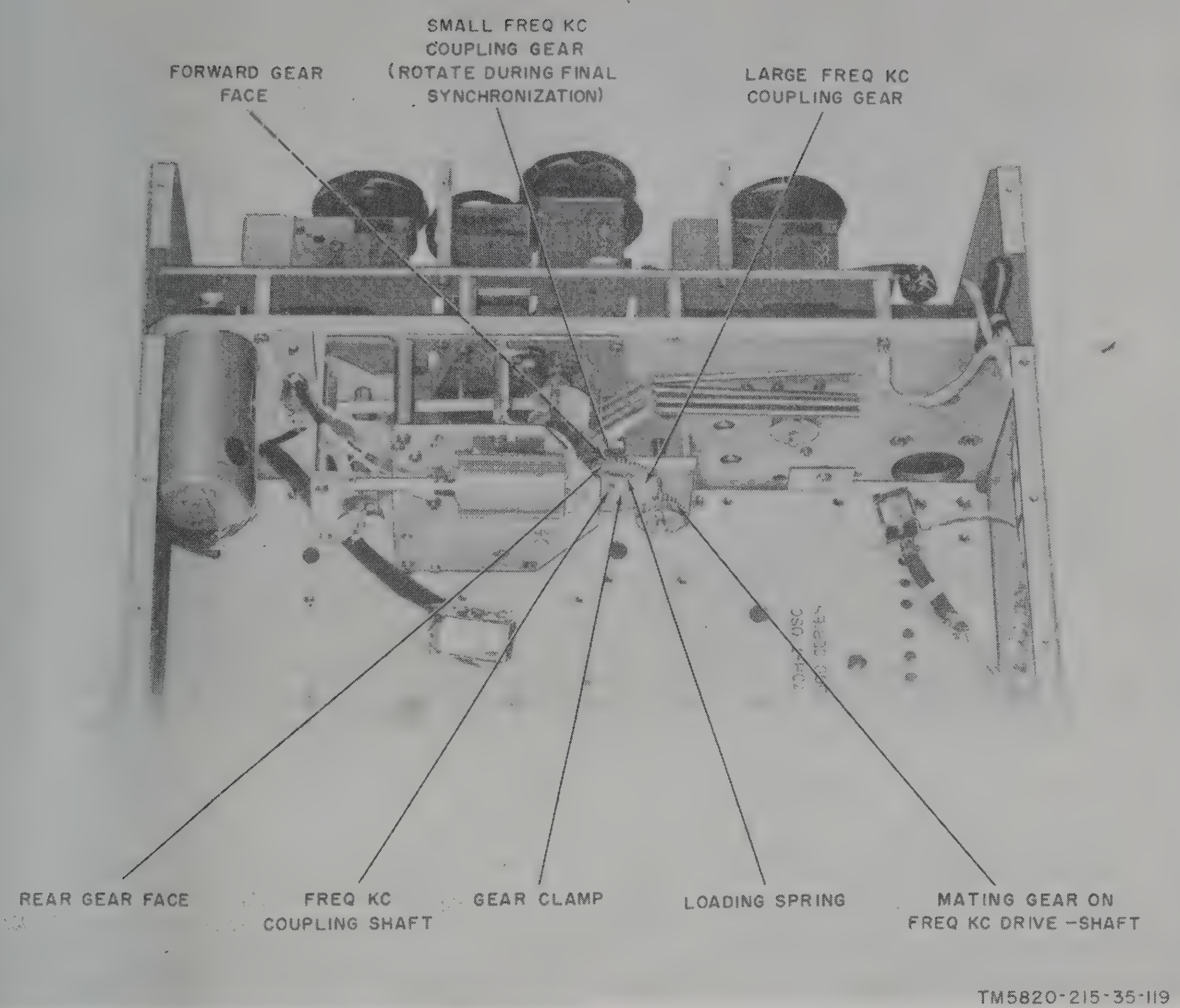


Figure 133. Mechanical interpolator installation, location of small and large FREQ-KC coupling gears.

end through the pulley clamp jaws. Hold the cord against the jaws, and turn the pulley until the dial mask slot is positioned over the last two FREQ-MC counter wheels, showing a dial reading of 16.3000 mc. Tighten the pulley clamp.

(5) Rotate the BAND control counterclockwise through the other detents, checking that the mask slot lines up on the low-frequency end of each band as successive detents are reached (16.3, 8.3, 4.3, 2.3, and 1.7 mc). If the mask slot does not center accurately on all bands, loosen the pulley clamp, readjust as necessary, and tighten.

m. Removal of Automatic Tuning Drive Motor B801 (fig. 104).

(1) Remove the front panel (par. 123*n*).

(2) Disconnect plug P815 from J815.

(3) Remove the three mounting screws holding the motor to the main gear plate. The screws are accessible through two holes in the gear plate and through a hole beside the FREQ-MC positioning head (fig. 136).

(4) Tip the motor to disengage the drive belt. Lift the belt off the drive sprocket, and work the motor free. If a replacement motor is to be installed, the drive sprocket will be in position on the replacement motor.

n. Replacement of Automatic Tuning Drive Motor B801 (fig. 104).

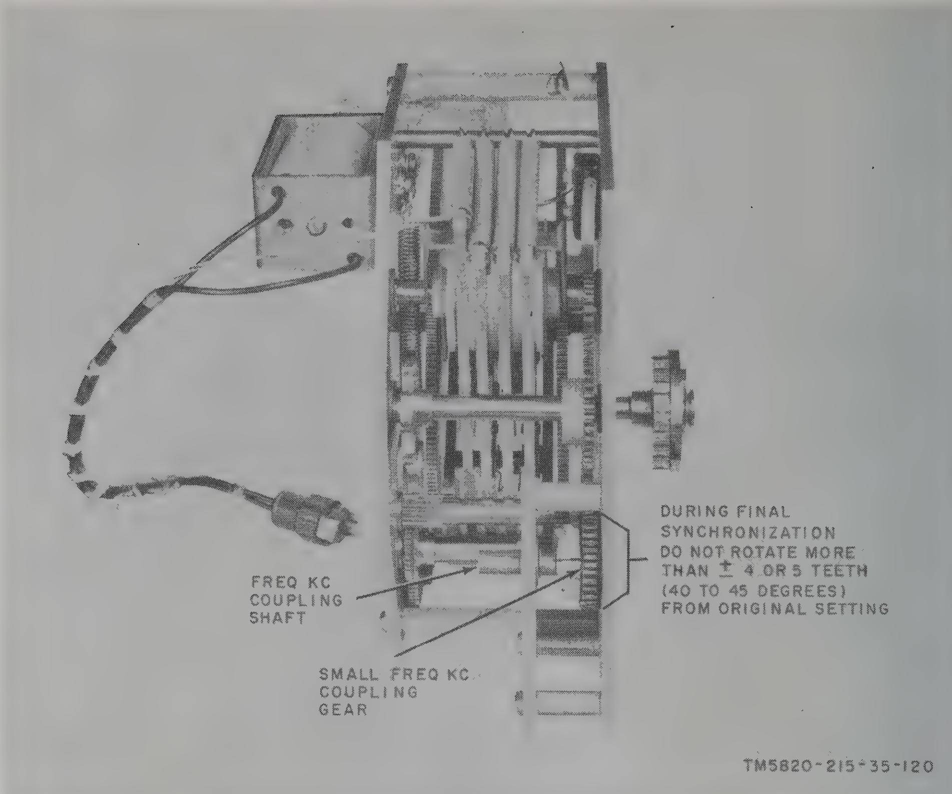


Figure 134. Mechanical interpolator installation, side view of small and large FREQ-KC coupling gears.

See C3 Figure 134.1 (Added)

(1) Position the motor to engage the drive sprocket to the belt drive.

(2) Replace the three mounting screws that hold the motor to the main gear plate. Be sure that the drive belt is properly placed on both sprockets before tightening the mounting screws.

(3) Connect P815 to J815.

(4) Replace the front panel (par. 123*o*).

See C1 Paragraph 124.1 (Added)

Section II. ALINEMENT

125. General

The alinement procedures in this section must be performed in the order given, except where noted in the alinement instructions. The frequency standard and the tsb modulator must be in complete alinement before attempting to aline the exciter-monitor. The frequency standard must be in complete alinement before attempting to aline the tsb modulator. The exciter-monitor must be in complete alinement before attempting to remove, replace, and synchronize the gain-frequency potentiometers (R803 or R810), the 0.5-kc detent microswitch, or the frequency counter dial assembly. The automatic tuning positioning or control heads may be removed, replaced, and synchronized regardless of the state of alinement of the exciter-monitor. Before performing any of the alinement or synchronization procedures described in this section, the power supply voltages should be checked and adjusted as noted in paragraph 127*a*.

126. Test Equipment Required

In addition to the equipment listed in paragraph 111 and tools that are furnished with the equipment, the following tools and equipment are required for the adjustment and alinement procedures given in this section:

Radio Receiver R390

Z2601 alinement tool

Z2602 alinement tool

Z2603 shorting tool
Z2604 alinement tool
Pinion crank H2609
Synchronizing tool H2613
Frequency Meter AN/TSM–16

127. Preliminary Alinement Adjustments

a. Power Supply Adjustments.

(1) Check the automatic line voltage control and, if necessary, adjust for 115 volts ac on the panel meter.

(2) Set the power supply meter switch to +125V EXCITER.

(3) Press the FILAMENT ON and PLATE ON buttons.

(4) The meter should indicate 10. If the meter does not indicate 10, adjust R2332 (fig. 73).

(5) Set the power supply meter switch to +210V EXCITER.

(6) The meter should indicate 10. If the meter does not indicate 10, adjust R2335 (fig. 73).

(7) Check all other power supply meter switch positions. The meter should indicate within the green area (approximately 10) in all positions. Refer to the power supply troubleshooting chart if a reading of 10 is not obtained.

***Caution:* Do *not* perform any alignment on this equipment unless the power outputs of the power supply are normal.**

b. Adjustment of Shaft Couplers in Exciter-Monitor. During the various steps in the removal and replacement procedures (section I), it may be necessary to change the slug rack drive mechanism adjustment on a subchassis. Whenever this adjustment is changed, use the following procedure to readjust the shaft couplers.

(1) Line up the coupler splines as directed in the replacement procedure.

(2) Loosen the coupler clamp and slide the movable half of the coupler along the shaft to engage the coupler.

(3) Tighten the coupler clamp setscrew while holding the coupler halves together.

(4) Test the coupler tension as follows:

(*a*) Observe the edge of the engaged coupler. The coupler consists of three sandwiched sections. Two of the sections (one end and the middle) are part of one coupler half; the third section is part of the mating coupler half.

(*b*) Using a screwdriver blade, apply pressure lightly to the middle coupler section. The section should be free to move slightly, sliding on the coupler splines.

(*c*) If the middle section will not move (slide) under light pressure, the coupler halves are engaged too tightly. Release the coupler clamp and repeat (2) and (3) above, until the conditions in (*b*) above are satisfied.

sups d ~~*c. Stabilized Master Oscillator Shaft Adjustment.*~~ c If the position of the oscillator shaft has been disturbed or if a new oscillator is installed, perform the procedure listed below:

(1) Turn the LINE switch to ON and allow the master oscillator to warm up for at least 1 hour.

(2) Disconnect P833 from J1102 (fig. 104). Connect the frequency counter to J1102. Energize the exciter-monitor.

(3) Connect shorting tool Z2603 to test point TP1706 and ground the clip lead. Set METER SWITCH S804 on the front panel to position 2, MO CONTROL CURRENT, and adjust R1742 on the error detector subchassis for a midscale reading on the meter.

(4) Rotate the stabilized master oscillator shaft until the frequency counter indicates an oscillator frequency of 2.000.

(5) Engage the coupler halves (*b* above).

(6) Remove the frequency counter from J1102. Reconnect P833 to J1102.

(7) Adjust the stabilized master oscillator to exact frequency (par. 131*a*).

d. Interpolation Oscillator Shaft Adjustment. If the position of the interpolation oscillator shaft has been disturbed or if a new oscillator is installed, perform the procedure listed below;

(1) Press the FILAMENT ON button and allow the equipment to warm up for at least 1 hour.

(2) Disconnect P1003 from J1702 (fig. 104). Connect P1003 and J1702 to two ends of a coaxial T-connector. Connect the frequency counter to the remaining end of the ~~T-connector.~~

S. psd c 3

(3) ~~Set the exciter-monitor controls for a fre-~~ quency setting of 2.3000 mc. Rotate the interpolation oscillator shaft until the frequency counter indicates 450.000 kc.

(4) See that the sum of the interpolation oscillator output and the frequency on the FREQ-KC dial (tunable from 00.0 kc to 99.9 kc) is always 450 kc (within ±50 cps). If the tolerance is greater than 50 cycles, refer to paragraph 131*b* and aline the interpolation oscillator.

(5) Engage the coupler halves (*b* above).

(6) Remove the frequency counter and the T-connector from P1003 and J1702. Con~~nect P1003 to J1702.~~

128. Synchronization of Exciter-Monitor Gear Train Components

a. Synchronization of Automatic Tuning System (figs. 108 and 135).

(1) Remove the exciter-monitor front panel (par. 123*n*).

(2) Remove automatic tuning control unit plug P805 (fig. 108). Set the ME–26B/U (par. 111) to OHMS, and connect between pin F of P805 and the chassis.

(3) Refer to figure 135. Using drive pinion crank H2609, rotate the drive pinion counterclockwise until the wafer switch in the control head and the cam drums in the three positioning heads are all rotating. The cam drums are on the shafts that have hexagonal nuts and Bristo centers at the front of the heads.

(4) Continue to rotate this pinion slowly counterclockwise until the multimeter indicates an open circuit. Be sure to stop the gears instantly when the meter indicates an open circuit.

(5) Rotate the drive pinion gear exactly four teeth (46°) clockwise.

(6) Insert automatic tuning synchronizing tool H2613 in the cam drum shaft of the head to be synchronized, and rotate the Bristo center shaft to its stop position. In the band positioning head, the shaft is rotated clockwise; in the frequency-kc and the frequency-mc positioning heads, the shafts are rotated counterclockwise to their stop positions.

(7) While holding the shaft with the Bristo wrench, loosen the hexagonal locking nut. In the FREQ-MC and FREQ-KC positioning heads, the locking nuts have left-hand threads. In the band positioning head, the locking nut has a right-hand thread.

(8) Rotate the Bristo wrench in the same direction as in (6) above until the cam drum again hits a stop.

(9) While holding the shaft with the Bristo wrench, tighten the locking nut. If the shaft is not held securely, the mechanism may be damaged.

(10) Perform (6) through (9) above for each head. After the heads have been synchronized, replace the front panel and see that the BAND, FREQ-MC, and FREQ-KC controls set up on every channel.

b. Synchronization of Gain-Frequency Potentiometers R803 and R810 (fig. 108).

(1) Rotate the BAND control, FREQ-MC control, and FREQ-KC control for a dial reading of 24.3000 mc (band 5).

(2) Connect the dc probe of Multimeter ME–26 to TP2210 (fig. 139). Connect the ground lead to the chassis. Set the multimeter to the 10V range.

(3) Release the gear clamp on the driving gear between the two potentiometers. Release the clamp on the gear connected to the shaft of R803. If the clamp on the driving gear is rotated so that the setscrew is not accessible, rotate the FREQ-MC control until the setscrew is positioned where it can be released. After releasing the setscrew, turn the FREQ-MC control until the dial reading is again 24.3000 mc.

(4) Press the FILAMENT ON button. Manually rotate the gear and shaft of potentiometer R803 (thus turning the gear and shaft of R810). The negative voltage at TP2210 should gradually decrease to zero. As the zero voltage is approached, switch the ME–26B/U to the 1V range for greater accuracy. The zero voltage point occurs at the midpoint of the potentiometer range.

***Caution:* If the negative voltage at TP2210 *increases* gradually, then suddenly drops to zero, the control was rotated in the wrong direction. Rotate**

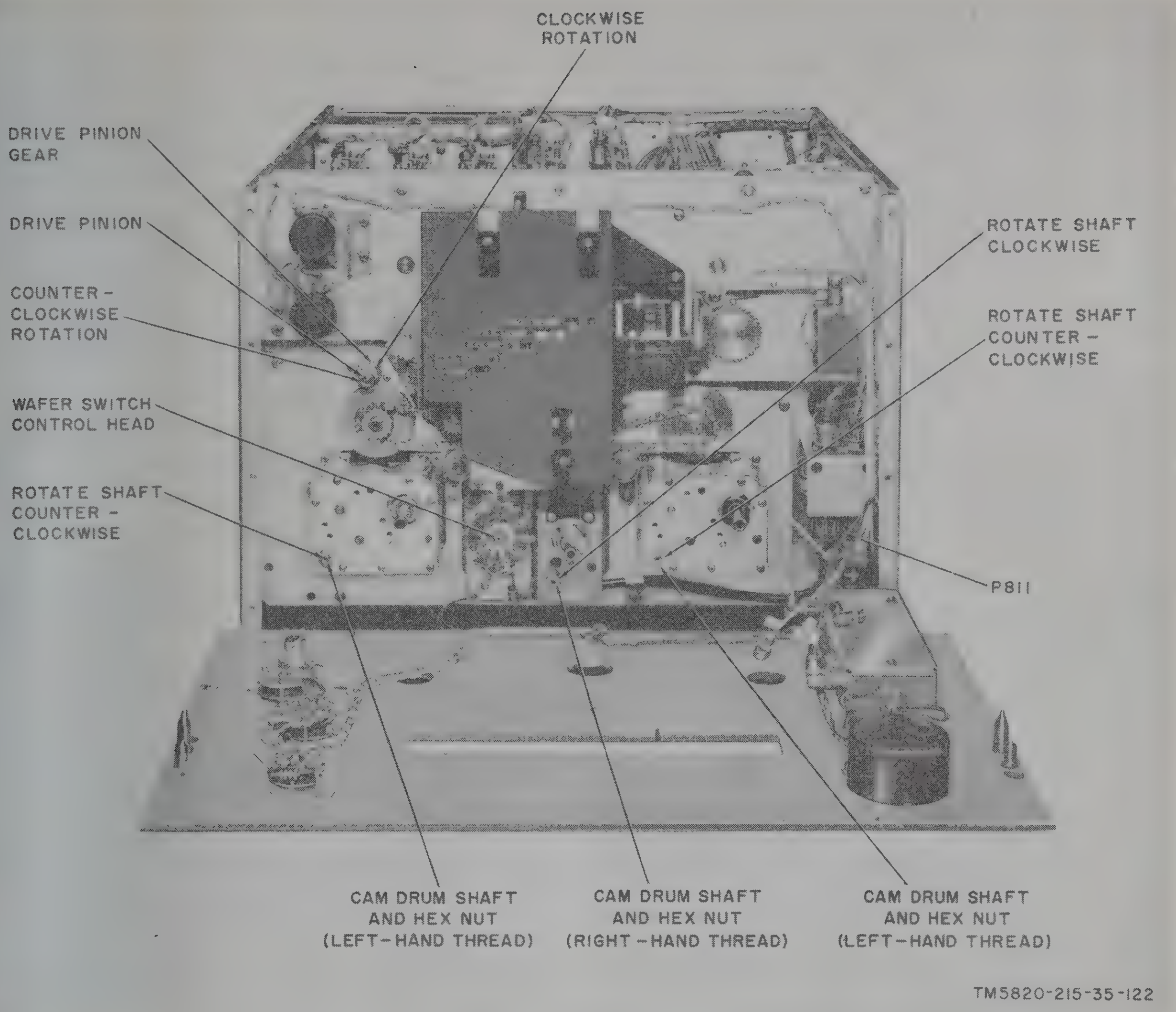


Figure 135. Exciter-monitor, front panel removed, automatic tuning components.

in the direction that results in a gradual decrease to zero.

(5) While holding the gear on the shaft of potentiometer R803 (to maintain zero voltage at TP2210 (fig. 139)), tighten the clamp on the driving gear between the two potentiometers.

(6) Remove the multimeter dc probe from TP2210 and connect it to TP1808 or TP1908 (fig. 139).

(7) Rotate the FREQ-MC and FREQ-KC controls to obtain a dial reading of 32.3000 mc (band 5).

(8) Slide the gear on the shaft of R803 toward the gear plate to expose about one-eighth inch of the shaft. Do not slide it far enough to unmesh this gear from the driving gear.

(9) Obtain a 2-foot length of thin, stout cord such as nylon lacing cord. Wrap 1 or 2 turns of cord around the exposed shaft of R803, leaving the ends of the cord free above the panel. The cord will act as a driving (friction) belt to turn the shaft of R803 ((10) below).

(10) Turn the shaft of R803 until the voltage at TP1808 or TP1908 just drops to zero. The shaft is turned by stretching the driving cord taut, then applying unequal tension to the cord ends so that the cord acts as a driving belt. If the cord slips, release the clamp on the gear far enough to permit

the shaft to rotate freely.

Note. The negative voltage at TP1808 or TP1908 should decrease gradually to zero as the shaft of R803 is rotated toward one end of the potentiometer range. If the voltage increases gradually, then suddenly drops to zero, the shaft is being rotated in the wrong direction. The correct setting of R803 is the point at which the voltage just reaches zero. For a few degrees beyond this point, the voltage will remain at zero. Any setting within this zero area is incorrect; the proper setting is the point at the exact start of the zero area.

c. Synchronization of Odd/Even 0.5-Kc Microswitch S805 (figs. 108 and 136).

(1) Remove the front panel (par. 123*n*).

(2) Remove plug P807 from J807. Plug P807 terminates the leads from the solenoid and microswitch assembly (fig. 108).

(3) Set the multimeter on OHMS and connect between pins D and F on plug P807.

(4) Replace the knob on the FREQ-KC main tuning shaft.

(5) While watching the multimeter, turn the FREQ-KC knob clockwise until the microswitch just actuates (opens if closed, closes if opened). Note the dial reading on the last counter dial at the exact point where the microswitch actuates. Interpolate between dial divisions if necessary.

(6) Continue rotating the FREQ-KC knob clockwise until the microswitch action reverses (opens if closed in (5) above, closes if opened in (5)). Note the dial reading on the last frequency counter dial at the exact point where the microswitch actuates. Interpolate between dial divisions if necessary.

(7) Continue rotating the FREQ-KC knob clockwise until the microswitch action again actuates, returning to the condition in (5) above. Note the dial reading on the last frequency counter dial at the exact point where the microswitch actuates. Interpolate between dial divisions if necessary.

(8) The last counter dial should have moved through exactly five dial divisions in (6) and five in (7) above. The total number of dial divisions covered in (6) and (7) above will always be 10. If the adjustment of the microswitch actuating lever is incorrect, one of the above steps will take more than five dial divisions (example: six) and the other less than five (example: four). If the adjustment is incorrect, proceed with (9), (10), and (11) below. If the adjustment is correct, omit (9) through (11) and proceed to (12) below.

(9) Refer to figure 136. Release the locking screw that secures the positioning cam under the microswitch actuating lever.

(10) Turn the positioning cam through a few degrees in either direction, and tighten the locking screws.

(11) Repeat (5) through (7) above and check the adjustment as explained in (8). Repeat (9) through (11) as often as required to obtain a spread of exactly five dial divisions in (6) and (7). It may be necessary to loosen the switch mounting screws and reposition the switch slightly to obtain an accurate adjustment.

(12) Rotate the FREQ-KC knob until the setscrew on the odd/even 0.5-kc cam clamp is accessible. The cam clamp is behind the cam (fig. 136). Release the setscrew.

(13) Rotate the FREQ-KC knob until the last counter dial indicates an exact odd number such as 05, 15, 25, etc.

(14) Manually rotate the cam until the small wheel on the microswitch actuating lever is exactly centered on a peak; that is, the center of the range which acuates the microswitch.

(15) Tighten the setscrew in the cam clamp. Rotate the FREQ-KC knob while observing the multimeter and the last counter dial. When the counter dial indicates 00, the microswitch should be open and should close when the counter dial indicates exactly 025 (midway between the 00 and 05 mark). Continue to rotate the FREQ-KC knob until the counter dial indicates exactly 075 (midway between the 05 and 10 mark). At this point, the microswitch should open. Continue to rotate the FREQ-KC knob, and see that the microswitch closes at points exactly 0.25 kc ahead of the odd 0.5-kc points, and opens at exactly 0.25 kc ahead of the even 0.5-kc point.

(16) Repeat (12) through (14) above until the conditions in (15) are satisfied.

(17) Remove the multimeter, reconnect P807 to J807, and replace the front panel (par. 123*o*).

d. Synchronization of Counter Dial Assembly (figs. 137 and 138).

(1) Set the 0.5 KC LOCK control to OFF. Connect the frequency counter to the output of the exciter-monitor at TP4401 (fig. 139). Set the BAND control on band 5. Energize the equipment. Rotate the FREQ-KC and FREQ-MC controls until the frequency counter indicates an output frequency of exactly 16.3000 mc. Lock the wingnuts on the three control knobs.

(2) Refer to figure 137. Release the gear clamps on the FREQ-KC and FREQ-MC counter dial drive gears.

(3) Manually rotate the last counter dial until the last two counter dials show a reading of 0 00.

(4) Manually rotate the last FREQ-MC counter dial (seventh dial from left) until the seven FREQ-MC dials read:

(*a*) 1.7 2.3 4 3 8 3 16 3 (fig. 138).

(*b*) Reading straight across, all dials should read: 1.7 2.3 4 3 8 3 16 3 0 00.

(5) Tighten the gear clamps on the FREQ-MC and FREQ-KC counter dial drive gears.

(6) Replace and adjust the dial mask as described in paragraph 124*l*.

(7) Replace the front panel (par. 123*o*).

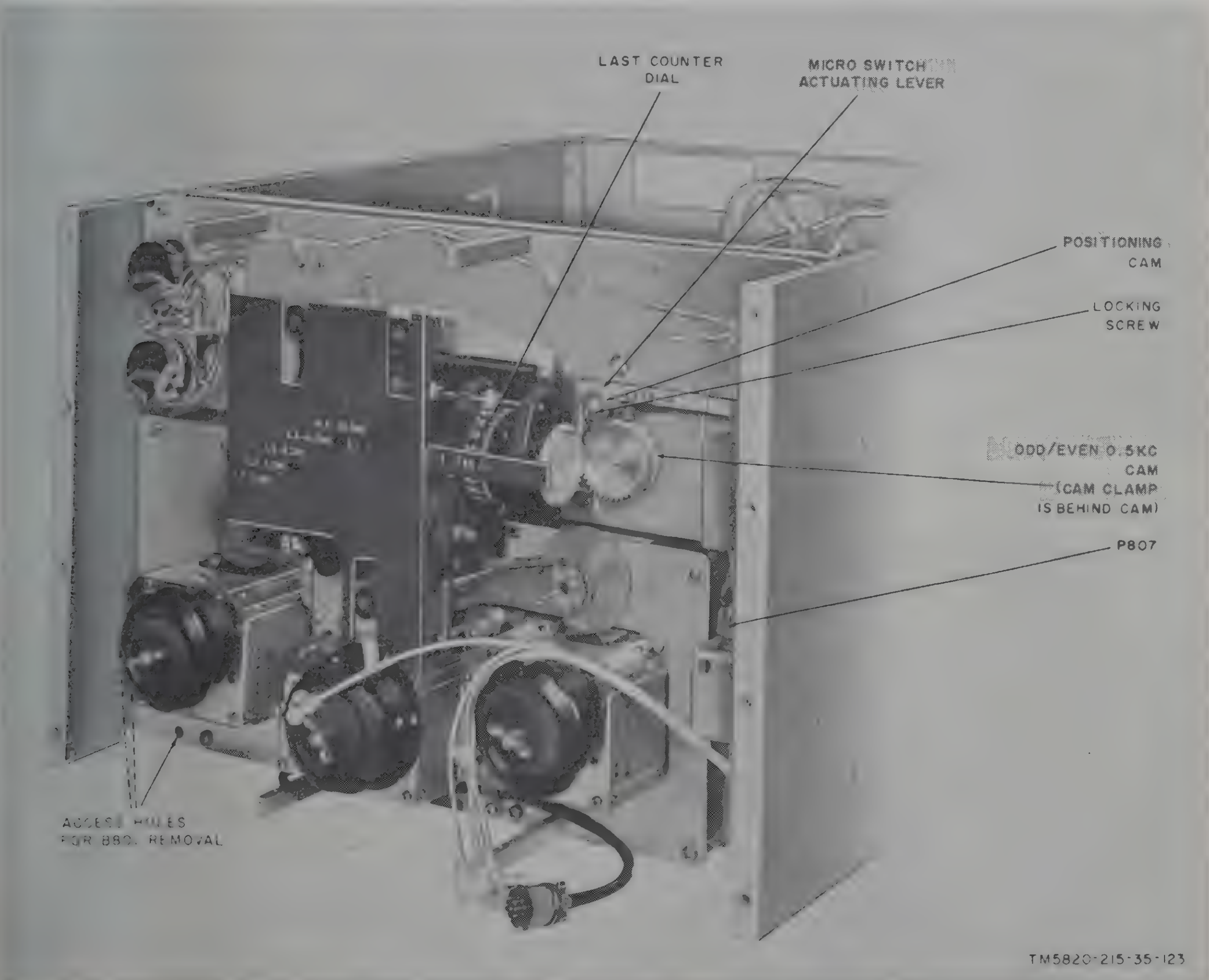


Figure 136. Exciter-monitor, front panel removed, 0.5-kc switch components.

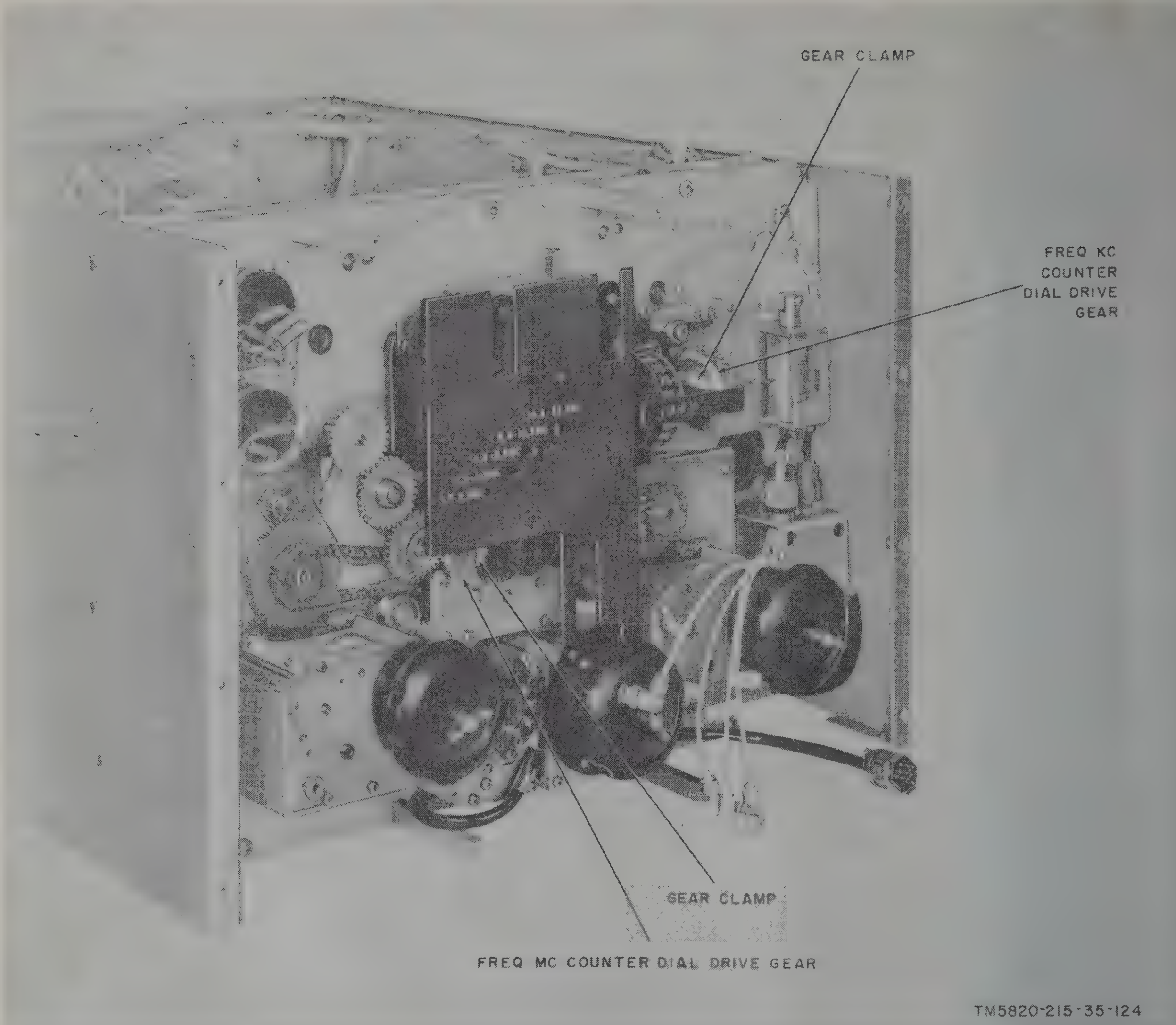


Figure 137. Exciter-monitor counter dial components.

129. Alinement of Frequency Standard Compartment
(figs. 79 and 80)

a. 1-Mc Crystal Oscillator. The 1-mc crystal oscillator, which serves as the frequency standard for the modulator-oscillator, is extremely precise, and consequently, requires no alinement procedure. However, before performing alinement procedures on other subchassis, see that the oscillator is functioning properly as follows:

(1) Set the METER switch on the frequency standard panel to position 1, OVEN-OSC. See that the meter indicates at least 4.

(2) Check the frequency of the oscillator as described in paragraph 16*d* of TM 11-5821-212-20.

b. 100-Kc and 300-Kc Generator.

(1) Disconnect 1-mc input plug P901 from J601.

(2) Apply a 100-kc, 2-volt signal from the RF meter (par. 111) to P901.

(3) Set the METER switch to position 5, 100 KV DIV.

(4) Connect Z2602 alinement tool between TP912 (on Z902) and ground.

(5) Tune Z901 to obtain a maximum reading on the frequency standard front-panel test meter.

(6) Set the METER switch to position 4, 300 KV DIV.

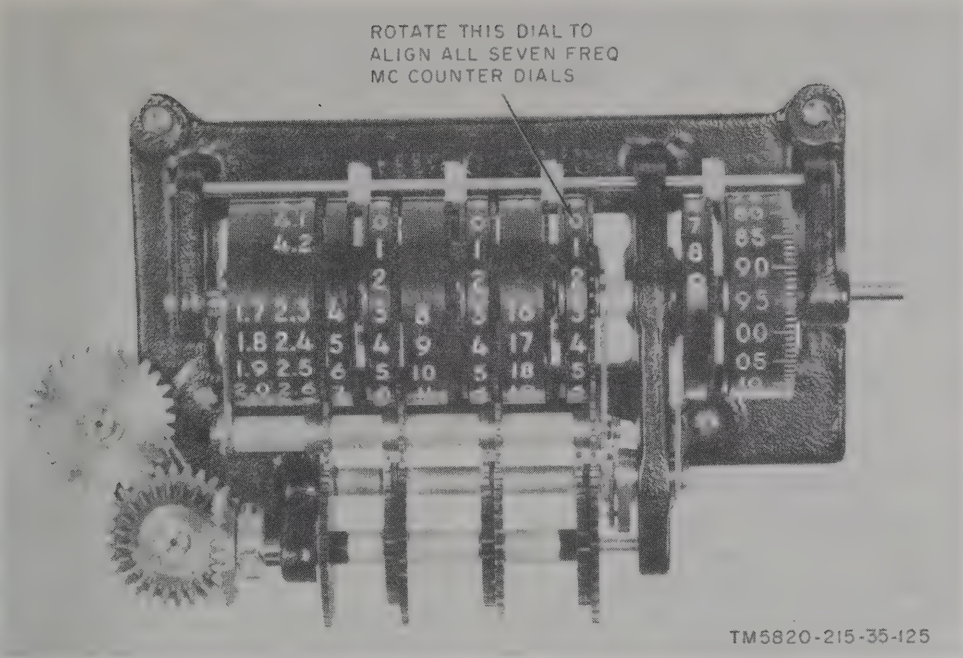


Figure 138. Exciter-monitor counter dial alignment.

(7) Tune Z903 for a maximum reading on the frequency standard front-panel meter.

(8) Set the METER switch to position 3, 900 KC DIV.

(9) Remove Z2602 alinement tool.

(10) Tune Z902 for a maximum reading on the frequency standard front-panel test meter.

(11) Disconnect the RF meter from P901.

(12) Reconnect P901 to J601.

(13) Trim the alinement by repeating (3) through (10) above omitting connection of Z2602 alinement tool.

c. 250- and 25-Kc Generator.

(1) Set the METER switch on position 6, 100 KC GEN.

(2) Tune Z504 and Z505 to obtain a maximum reading on the frequency standard front-panel meter.

(3) Adjust R701 (100-kc level adjustment) (fig. 79) to obtain a reading of 7.0 on the frequency standard front-panel test meter.

(4) Turn the adjusting screw of Z505 clockwise to obtain a reading of 6.0 on the frequency standard front-panel meter.

(5) Turn the adjusting screw of Z504 counterclockwise to obtain a reading of 5 on the frequency standard front-panel meter.

(6) Connect Multimeter ME–26/U to TP502. See that the 100-kc output is 2 volts root mean square (rms).

(7) Remove the ME–26/U.

(8) Set the METER switch on position 8, 75/100 KC.

(9) Tune Z501 to obtain a maximum reading on the frequency standard front-panel meter.

(10) Set the METER switch on position 7, 250 KC GEN.

(11) Tune Z502, Z506, and Z507 to obtain a maximum reading on the frequency standard front-panel test meter. Check the frequency of the 250-kc signal at TP505 with the frequency counter.

(12) Adjust R702 (250 KC LEVEL) (fig. 79) to obtain a reading of 5 on the frequency standard front-panel test meter.

(13) Check the 250-kc output voltage at TP505 with the ME–26/U for a 3-volt rms indication.

d. 25-Kc to 1-Kc Divider. No alinement is required for this subchassis. Check the operation of this divider circuit as follows:

(1) Set the METER switch to position 9, 5 KC DIV, and see that the frequency standard front-panel test meter indicates at least 4.

(2) Set the METER switch to position 10, 1 KC DIV, and see that the frequency standard front-panel test meter indicates at least 4.

(3) If the meter indications listed in (1) and (2) above are not obtained, refer to the frequency standard compartment troubleshooting chart (par. 117). Do not attempt further alinement procedures until correct readings are obtained.

e. 4.5-Kc Generator. No alinement is required for this subchassis. Check the operation of this circuit as follows:

(1) Set the METER switch to position 11, 1.5 KC GEN. See that the frequency standard front-panel test meter indicates at least 2.

(2) Set the METER switch to position 12, 4.5 KC GEN. See that the frequency standard front-panel test meter indicates at least 3.

(3) If the meter indications listed in (1) and (2) above are not obtained, refer to the frequency standard compartment troubleshooting chart (par. 117). Do not attempt further alinement procedures until correct readings are obtained.

130. Alinement of Tsb Modulator

(fig. 91)

***Caution:* Do *not* attempt to aline the tsb modulator until the alignment procedures for the frequency standard have been performed.**

a. Twin-Sideband Generator.

(1) Connect the ac probe of the ME–26/U to TP201 on Z201; tune the slug in Z201 for maxium voltage at TP201 (approximately 150 volts rms).

(2) Disconnect P204 from J4201 and connect the ME–20B/U to P204.

(3) Set UPPER SIDEBAND and LOWER SIDEBAND switches to OFF.

(4) Set the DB CARRIER ATTENUATION controls to their counterclockwise stops.

(5) Remove V203 from its socket.

(6) Set R264 and R265 to their clockwise stops.

(7) Turn BALANCE potentiometer R235 to its counterclockwise stop. Then turn the potentiometer 12½ turns clockwise.

***Caution:* Be careful not to break through the stops on the BALANCE potentiometers.**

(8) Adjust BALANCE potentiometer R238 fo minimum voltage at P204.

(9) Readjust R235 for a minimum voltage a P204.

(10) Repeat (8) and (9) above until no furthe decrease in voltage at P204 is noted.

(11) Replace V203 and remove V202.

Note. Be sure that V203 and V202 are *no* interchanged during the above or followin operations.

(12) Repeat (7) through (10) above, usin BALANCE potentiometers R245 an R248.

(13) Replace V202.

(14) Set DB ATTENUATION controls to (

(15) Set R202 to obtain a reading of .02 vol on the ME–30B/U. This is a preliminar adjustment. Potentiometer R202 is give a final adjustment after the remainder o the tsb modulator alinement is complete.

(16) Remove the test equipment and connec P204 to J4201.

b. 100- to 400-Kc Multiplier.

(1) Set the ME–26/U to AC and connect i to TP4101. See that the meter indicate 2 volts rms.

(2) Connect the ME–26/U to TP4111 o Z4101.

(3) Tune Z4101 to obtain a maximum indica tion on the ME–26/U.

(4) Connect the ME–26/U to TP4102.

(5) Tune Z4102 to obtain a maximum indica tion on the ME–26/U.

(6) Connect the frequency counter to TP410 See that the frequency at TP4102 is 200 k (twice the frequency at TP4101).

(7) Disconnect the test equipment fron TP4102.

(8) Connect the ME–26/U to TP4113 o Z4103.

(9) Tune Z4103 for maximum indication o the ME–26/U.

(10) Connect the ME–26/U to TP4103 an tune Z4104 for maximum.

(11) Use the frequency counter to check for 400-kc signal at TP4103 (twice the fre quency at TP4102).

(12) Successively retune Z4101, Z4102, Z410 and Z4104 to obtain a maximum 400-k

output voltage at TP4103. Disconnect the frequency counter from the subchassis before making this adjustment. Check the output voltage at TP4103 for a meter indication of 2.8 volts rms (±0.5 volt).

c. 300-Kc Converter. No alinement procedure is ecessary for this subchassis. Check the 300-kc tsb utput at TP406 with a frequency counter. If the requency range is not 296 to 306 kc, refer to the sb troubleshooting chart (par. 118). Do not attempt further alinement procedures until the signal t TP406 is normal.

d. Alc Amplifier.

(1) Plug the Z2602 alinement tool into TP401 on Z401. Ground the other end of the tool on the alc amplifier subchassis.

(2) Set the DB CARRIER ATTENUATION control to 0 and set the alc switch to OFF. In the OFF position, the alc switch disconnects the alc signal from the power amplifier and grounds the bus to disable the alc circuit.

(3) Connect the ME–30B/U to TP4501 on the agc amplifier.

(4) Tune Z402 to obtain a maximum indication on the ME–30B/U.

(5) Disconnect the Z2602 alinement tool from TP401 and plug it into TP402 on Z402.

(6) Tune Z401 for a maximum indication on the ME–30B/U.

(7) Tune Z403 for a maximum indication on the ME–30B/U.

(8) Disconnect the alinement tool.

(9) Remove the ME–30B/U.

(10) Set the alc switch to ON.

e. Tsb Modulator Output.

(1) Set the DB CARRIER ATTENUATION controls to their counterclockwise stops and place the alc switch to OFF.

(2) Connect the ME–30B/U to TP4501.

(3) Remove P204 from J4201.

(4) Tune Z4104 for minimum output. This should occur at not more than ¼ turn from the setting for maximum output from the 100-kc to 400-kc multiplier.

(5) Reconnect P204 to J4201.

(6) Apply a standard two-tone test signal to LINE 1.

Note. The two-tone test signal can be obtained from the two audio oscillators listed in paragraph 110. Set one audio oscillator to 3,000 cps and the other to 5,000 cps. The amplitude of both tones must be the same.

(7) Set the LINE 1 METER switch to +6.

(8) Set the UPPER SIDEBAND switch to LINE 1. See that the LOWER SIDEBAND switch is not on LINE 1, and set the band switch on the exciter-monitor to some band other than band 1 to deenergize the sideband interchange relay.

(9) Set the LINE 1 level control to obtain a panel meter reading of 0.

(10) Turn off the 5,000-cps tone, while maintaining proper termination for impedance match.

(11) Adjust R264 to obtain an indication of 0.2 volt rms on the ME–30B/U.

(12) Set the UPPER SIDEBAND switch to OFF.

(13) Set the LOWER SIDEBAND switch to LINE 1.

(14) Adjust R265 to obtain an indication of 0.2 volt rms on the ME–30B/U.

(15) Set the LOWER SIDEBAND switch to OFF.

(16) Set the DB CARRIER ATTENUATION controls to 0.

(17) Determine the reference level to which the DB CARRIER ATTENUATION controls are to be calibrated.

Note. When the equipment is shipped from the factory, the reference level is adjusted to equal one tone of a standard two-tone signal of sufficient amplitude to produce a reading of 0 on the panel meter of the line in use when the METER switch is in the +6 position. This reference level corresponds to a level 6 db below peak envelope power.

(18) Use the following chart as a guide for adjustment of this reference level:

Reference level	ME–30B/U indication at TP4501
Peak envelope power	0.4 volt ac rms
One tone of standard two-tone test signal	0.2 volt ac rms

(19) Adjust R202 on the twin-sideband generator subchassis to obtain the reference level required.

(20) Turn the DB CARRIER ATTENUATION controls to their counterclockwise stops.

(21) Assign any convenient order of adjustment to BALANCE potentiometers R235, R238, R245, and R248. Trim each BALANCE potentiometer, in turn, until a minimum indication on the ME–30B/U is reached.

(22) Repeat (18) above to be sure that no further decrease in ME–30B/U readings is obtained by adjustment of any of the four potentiometers.

(23) Trim the slug of Z201 for a minimum indication on the ME–30B/U. The minimum should be within one-half turn of the setting in *a*(1) above. If the above setting does not produce a minimum, repeat the procedure in *a*(1) above.

(24) Set the alc switch to ON.

f. Calibration of Alc Metering.

(1) Remove all audio inputs from the tsb modulator and set the DB CARRIER ATTENUATION controls to zero.

(2) Make sure that the power amplifier (if connected) is turned off.

(3) Set alc OFF-ON switch S401 to OFF.

(4) Connect the ME–30B/U to TP4501 to measure the output of the tsb modulator.

(5) Set METER switch S4003 *or* S4004 to ALC.

(6) Adjust R422 for a reading of 0 on the panel meter.

(7) Set the alc OFF-ON switch to ON.

(8) Connect a variable dc voltage source (approximately 0 to 3 volts dc, negative with respect to ground) to TP405.

(9) Adjust the negative dc voltage to reduce the output of the tsb modulator to 6 db from the level obtained with S401 at OFF.

(10) Adjust R420 for a reading of —6 on the panel meter.

Note. While performing the following steps, see that the meter connected to TP4501 indicates a 6-db change in level each time S401 is operated.

(11) Turn S401 to OFF and readjust R422 for 0 on the panel meter.

(12) Turn S501 to ON and readjust R420 for —6 on the panel meter.

(13) Repeat (11) and (12) above until no further adjustment is required.

(14) Disconnect the test equipment and set switches for normal operation.

131. Alinement of Exciter-Monitor

(figs. 103 through 105 and 139)

***Caution:* Do not aline the exciter-monitor until the alinement procedures for the frequency standard and the tsb modulator have been completed. Perform the alinement procedures for each subchassis in the exciter-monitor in the exact order in which they are listed.**

a. Stabilized Master Oscillator. Perform the following alinement procedures ~~when replacing the stabilized master oscillator or~~ when the exciter-monitor panel meter indicates that the smo control current deviation from 0 center is ±3 or more.

(1) Disable the smo servo loop by shorting TP1706 with the Z2603 shorting tool.

(2) Set the METER SWITCH on the exciter-monitor panel at position 2, MO CONTROL CURRENT.

(3) Adjust potentiometer R1742 in the smo error detector to obtain an exact midscale indication on the exciter-monitor panel meter.

(4) Set the CHANNEL selector switch to position 1.

(5) Turn the wingnuts associated with the FREQ-MC, BAND, and FREQ-KC controls counterclockwise.

(6) Set the BAND selector on band 2 and tune the exciter to 2.3000 mc.

***Caution:* After tuning the exciter-monitor, tighten the three wingnuts on the tuning controls.**

(7) Connect the frequency counter to TP1522 (2–4 mc input on the smo rf chassis).

(8) Adjust the master oscillator calibration adjustment screw (nylon worm), near the front of the master oscillator mounting frame, until the master oscillator output is 2.0000 mc. (The master oscillator unit is the subchassis directly in line with the FREQ-MC knob shaft.)

(9) Unlock the FREQ-MC control, and tune the exciter in 100-kc increments from 2.3 mc to 4.3 mc. For each frequency setting

on the dial, the master oscillator frequency must be 300 kc (±1.5 kc) below the dial reading. See C3 Sentence (Added)

(10) Remove Z2603 shorting tool from TP1706 in the smo error detector.

(11) Disconnect the test equipment from ~~TP1502.~~ TP1522 Supsd C3

(12) Tighten the wingnuts on the control knobs.

See C3 *b. Interpolation Oscillator* (fig. 104). Perform these procedures ~~when replacing the interpolation oscillator or~~ when an operational check of the transmitting group indicates drift in the interpolation oscillator output. The interpolation oscillator is tuned between 450 and 350 kc as the FREQ-KC dial is tuned from 000 to 999 (actually 00.0 kc to 99.9 kc). Correct readings are shown on the chart below:

Reading on last 3 digits, frequency dial	Interpolation oscillator output (kc)
000	450.0
500	400.0
999	350.1

(1) Insert a T-connector (supplied with the equipment) between P1003 and J1702, and connect the frequency counter to the T-connector. See C3 Subsub Paragraph (Added)

(2) Adjust the interpolation oscillator calibration adjustment screw (nylon worm) located near the front of the interpolation oscillator mounting frame to adjust the interpolation oscillator output to ~~450.0~~ 350.0 kc. Supsd C3 (The interpolation oscillator unit is the subchassis directly in line with the FREQ-KC knob shaft.)

(3) Operate the FREQ-KC control over its entire range (100 kc). Check that the sum of the interpolation oscillator output frequency and the dial reading is always 450.0 kc, ±50 cps. See C3 Sentence (Added)

(4) Disconnect the test equipment and T-connector from plug P1003 and J1702. Reconnect P1003 to J1702.

c. Smo Error Detector (figs. 104 and 105).

(1) Disable the smo servo loop by shorting TP1706 with the Z2603 shorting tool.

(2) Set the METER SWITCH on the exciter-monitor panel at position 2, MO CONTROL CURRENT.

(3) Adjust potentiometer R1742 in the smo error detector to obtain an exact midscale indication on the exciter-monitor panel meter.

(4) Remove the ground from TP1706.

d. Smo Rf Subchassis (figs. 104 and 105).

(1) Check that the stabilized master oscillator is properly alined (*a* above).

(2) Set the frequency controls to 1.7000 mc, and measure the distance between the top of the coil covers and the bottom of the slug rack of the smo rf chassis. This distance must be at least .058 inch before any of the following alinement procedures are attempted. At this setting, the splines or notches of the tuning couplers must be vertical. Check that the rotors of the band switch wafers are set correctly for band 1.

(3) Use the CHANNEL, BAND, FREQ-MC, and FREQ-KC controls to set up the following frequencies on the exciter-monitor.

***Caution:* Always tighten the three wingnuts on the BAND, FREQ-MC, and FREQ-KC controls after each setting before repositioning the CHANNEL selector.**

Channel	Band	Dial reading (mc)
3	2	2.3500
4	2	4.3500
5	3	4.3500
6	3	8.3500
7	4	8.3500
8	4	16.3500
9	5	16.3500
10	5	30.0500

Note. If the exciter-monitor panel meter readings are not obtained during the performance of the following procedures, proceed to *i* below.

e. 2-4-Mc Buffer Amplifier (fig. 139).

(1) Set the METER SWITCH on position 5, LOW FREQ INJECTION. Check the output of stabilized master oscillator buffer amplifier V1503.

(2) Set the CHANNEL selector on 3 and short TP1533 to ground with the Z2603 shorting tool.

(3) Connect the Z2601 alinement tool to TP1509 on Z1509 and adjust the slug of Z1510 for a maximum indication on the exciter-monitor front-panel meter.

(4) Connect Z2601 alinement tool to TP1510 on Z1510 and adjust the slug of Z1509 for a maximum indication on the exciter-monitor panel meter.

(5) Set the CHANNEL selector on 4.

(6) Connect Z2601 alinement tool to TP1509, and tune C1510 in Z1510 for a maximum indication on the exciter-monitor panel meter.

(7) Connect Z2601 alinement tool to TP1510 and tune C1509 in Z1509 for a maximum indication on the exciter-monitor panel meter.

(8) Repeat (2) through (7) above as often as required to aline Z1509 and Z1510 accurately.

(9) Disconnect Z2601 alinement tool, and remove Z2603 shorting tool from TP1533.

f. 6-12-Mc Multiplier (fig. 139).

(1) Set the METER SWITCH on position 6, HIGH FREQ INJECTION, to measure the output of frequency multiplier V1506.

(2) Set the CHANNEL selector on 5.

(3) If the exciter-monitor panel meter indicates at least 1, proceed to (8) below. If not, connect the radio receiver (par. 126) to TP1527 at the output of the 6-12-mc multiplier stage; use a probe consisting of a series capacitor between 5 and 10 uuf and a length of coaxial cable to connect the receiver antenna receptacle to the probe.

(4) Tune the radio receiver to 6.075 mc, and adjust the slugs of Z1513, Z1516, and Z1517 to obtain a maximum reading on the carrier level meter of the receiver.

(5) Set the CHANNEL selector on 6, and tune the radio receiver to 12.075 mc.

(6) Adjust C1513 in Z1513, C1516 in Z1516, and C1517 in Z1517 to obtain a maximum reading on the carrier level meter of the receiver.

(7) Disconnect the receiver from TP1527.

(8) Set the CHANNEL selector at 5.

(9) Adjust the slug of Z1513 to obtain a maximum indication on the exciter-monitor panel meter.

(10) Tune the slug in Z1516 for a maximum indication on the exciter-monitor front-panel meter.

(11) Tune the slug in Z1517 for a maximum reading on the exciter-monitor panel meter.

(12) Set the CHANNEL selector at 6.

(13) Tune C1513 in Z1513 to obtain a maximum reading on the exciter-monitor panel meter.

(14) Tune C1516 in Z1516 for a maximum indication on the exciter-monitor panel meter.

(15) Tune C1517 in Z1517 for a maximum indication on the exciter-monitor panel meter.

(16) Repeat (8) through (15) above as often as required to aline Z1513, Z1516, and Z1517 accurately. The panel meter reading should be between 5 and 7.

g. 14-28-Mc Multiplier (fig. 139).

(1) Set the CHANNEL selector on 9.

(2) If the exciter-monitor panel meter indicates at least 1, proceed to (14) below. If not, connect the radio receiver to TP1528; use a coaxial cable and a capacitor as described in *f*(3) above.

(3) Tune the slug of Z1514 to obtain a maximum reading on the carrier level meter of the receiver (tuned to the signal at 14.04375 mc).

(4) Tune the slug of Z1515 to obtain a maximum indication on the carrier level meter of the receiver.

(5) Tune the slug of Z1518 for a maximum indication on the carrier level meter of the receiver.

(6) Tune the slug of Z1519 for a maximum indication on the carrier level meter of the receiver.

(7) Set the CHANNEL selector to 10.

(8) Tune C1514 in Z1514 to obtain a maximum indication on the carrier level meter of the receiver (tuned to 26.03125 mc).

(9) Tune C1515 in Z1515 to obtain a maximum indication on the carrier level meter of the receiver.

(10) Tune C1518 in Z1518 for a maximum indication on the carrier level meter of the receiver.

(11) Tune C1519 in Z1519 for a maximum indication on the carrier level meter of the receiver.

(12) Disconnect the receiver from TP1528.

(13) Set the CHANNEL selector at 9.

(14) Repeat (3) through (6) above, except tune for a maximum indication on the exciter-monitor panel meter.

(15) Set the CHANNEL selector at 10.

(16) Repeat (8) through (11) above, except tune for maximum readings on the exciter-monitor front-panel meter.

(17) Repeat (13) through (16) above as required to aline Z1514, Z1515, Z1518, and Z1519 accurately.

h. 100-Kc Spectrum Generator (fig. 139).

(1) Connect the ME–26/U to TP1501 on Z1501. Adjust the slug of Z1501 for maximum reading on the ME–26/U (90 volts ac rms or more). Disconnect the ME–26/U.

(2) Set the METER switch at 3, Ø DETECTOR INPUT, to measure error signal limiter level.

(3) Set the CHANNEL selector on 3.

(4) Connect the Z2604 alinement tool to TP1512 in Z1512, and tune the slug of Z1502 (2.65-4.65 mc) to obtain a maximum reading on the exciter-monitor panel meter.

(5) Tune the slug of Z1511 to obtain a maximum reading on the exciter-monitor panel meter.

(6) Connect the Z2604 alinement tool to TP1511 in Z1511, and tune the slug of Z1512 to obtain a maximum reading on the exciter-monitor panel meter.

(7) Set the CHANNEL selector at 4.

(8) Connect the Z2604 alinement tool to TP1512 in Z1512, and tune C1502 in Z1502 for a maximum reading on the exciter-monitor panel meter.

(9) Tune C1511 in Z1511 to obtain a maximum reading on the exciter-monitor panel.

(10) Connect Z2604 alinement tool to TP1511 in Z1511, and tune C1512 in Z1512 to obtain a maximum reading on the exciter-monitor panel meter.

(11) Disconnect Z2604 alinement tool.

(12) Repeat (3) through (11) above as often as required to align Z1502, Z1511, and Z1512.

(13) A reading between 2 and 5 should be obtained on the exciter-monitor panel meter for channels 3 and 4.

(14) Set the CHANNEL selector at 5.

(15) Connect Z2604 alinement tool to TP1512 in Z1512, and tune the slugs in Z1503 and Z1504 (4.65-8.65 mc) to obtain a maximum reading (between 2 and 5 with Z2604 alinement tool removed) on the exciter-monitor panel meter.

(16) Set the CHANNEL selector at 6.

(17) With Z2604 alinement tool connected to TP1512 in Z1512, tune C1503 and C1504 in Z1503 and Z1504 respectively, to obtain a maximum reading on the exciter-monitor panel meter.

(18) Repeat (14) through (17) above as required to aline Z1503 and Z1504 accurately.

(19) Set the CHANNEL selector at 7.

(20) With the Z2604 alinement tool connected to TP1512 in Z1512, tune the slugs in Z1505 and Z1506 (8.65-16.65 mc) to obtain a maximum reading on the exciter-monitor panel meter.

(21) With Z2604 alinement tool connected to TP1512, set the CHANNEL selector at 8.

(22) Adjust C1505 and C1506 in Z1505 and Z1506, respectively, to obtain a maximum reading on the exciter-monitor panel meter.

(23) Repeat (19) through (22) above as required to aline Z1505 and Z1506 accurately.

(24) Set the CHANNEL selector at 9; leave Z2604 alinement tool on TP1512.

(25) Tune the slugs in Z1507 and Z1508 (16.65-32.65 mc) to obtain a maximum reading on the exciter-monitor panel meter.

(26) Set the CHANNEL selector at 10; leave Z2604 alinement tool on Z1512.

(27) Adjust C1507 and C1508 in Z1507 and Z1508, respectively, to obtain a maximum reading on the exciter-monitor panel meter.

(28) Repeat (24) through (27) above as required to aline Z1507 and Z1508 accurately.

(29) To insure that the smo rf chassis is properly alined, retrim all the tank circuits. Perform the steps in *e*(1) through (9) above, *f*(1) and (8) through (15) above, *g*(13) through (16) above, and (2) through (10), (14) through (17), (19) through (22), and (24) through (27) above to retrim the chassis. The final trimming adjustment in each case should be the slug adjustment at the low end of each band.

i. Alinement of Smo RF Chassis in Case of Extreme Misalinement (fig. 104 and 139).

(1) Perform the operations in *d* above.

(2) Ground TP1706 on the smo error detector with Z2603 shorting tool.

(3) Connect the ME–26/U to TP1501 on Z1501 and adjust the slug of Z1501 for maximum reading on the ME–26/U (90 volts ac rms or more). Remove the multimeter.

(4) Expose 1½ inches of the insulated inner conductor of a length of coaxial cable. Insert the exposed, insulated, inner conductor into the shield around tube V1505, and connect the other end of the cable to the receiver antenna receptable.

(5) Set the CHANNEL selector to 3.

(6) Tune the receiver to 2.7 mc, and adjust the slugs in Z1502, Z1511, and Z1512 for maximum indication on the receiver carrier level meter.

(7) Set the CHANNEL selector to 4.

(8) Tune the receiver to 4.7 mc, and tune the trimmer capacitors in Z1502, Z1511, and Z1512 for maximum indication on the receiver carrier level meter.

(9) Connect the receiver to tube V1504 by following the method in (4) above.

(10) Set the CHANNEL selector to 5.

(11) Tune the receiver to 4.7 mc, and adjust the slugs of Z1503 and Z1504 for maximum indication on the receiver carrier level meter.

(12) Set the CHANNEL selector to 6.

(13) Tune the receiver to 8.7 mc, and tune the trimmer capacitors in Z1503 and Z1504 for maximum indication on the receiver carrier level meter.

(14) Repeat (10) through (13) above as often as required to aline Z1503 and Z1504 accurately.

(15) Set the CHANNEL selector to 7.

(16) With the receiver tuned to 8.7 mc, adjust the slugs in Z1505 and Z1506 for maximum indication on the receiver carrier level meter.

(17) Set the CHANNEL selector to 8.

(18) Tune the receiver to 16.7 mc, and tune the trimmer capacitors in Z1505 and Z1506 for maximum indication on the receiver carrier level meter.

(19) Repeat (15) through (18) above as often as required to aline Z1505 and Z1506 accurately.

(20) Set the CHANNEL selector to 9.

(21) With the receiver tuned to 16.7 mc, adjust the slugs of Z1507 and Z1508 for maximum indication on the receiver carrier level meter.

(22) Set the CHANNEL selector to 10.

(23) Unlock the FREQ-MC and FREQ-KC controls and tune to 29.9500 mc. Relock the controls.

(24) Tune the receiver to 30.3 mc, and tune the trimmer capacitors in Z1507 and Z1508 for maximum indication on the receiver carrier level meter.

(25) Repeat (20) through (24) (omit (23)) as often as required to aline X1507 and Z1508.

(26) Reset channel 10 to 30.0500 mc.

(27) Follow the instructions in *c* above and complete the alinement procedure.

(28) Disconnect and remove the coaxial test cable ((4) above).

j. 0.5-Kc Spectrum Detent (fig. 104 and 105).

(1) Set the 0.5 KC LOCK switch to ON. Set the FREQ-KC dial to 000.

(2) Operate the METER SWITCH to position 4 to measure Ø DETECTOR REFERENCE input on the exciter-monitor panel meter.

(3) Remove P1002 from J1202 and remove P827 from J1203. Move P830 from J1206 to J1203. Adjust the slug of Z1207 for a maximum indication on the exciter-monitor front-panel meter. Reconnect P830 to J1206, P827 to J1203, and P1002 to J1202.

(4) Operate the FREQ-KC control to position the dial on 99.0.

(5) Turn the adjustment screw of the tuning slug for tuning circuit Z1201 until the end of the slug is even with the coil form; then turn the slug out (counterclockwise) ½ turn.

(6) While the dial indicates 99.0, adjust the trimmer capacitor circuit of Z1201 for peak reading on the meter.

(7) Operate the FREQ-KC control for a reading of 01.0 at the low-frequency end of the dial.

(8) Adjust the slug of trimmer coil L1202 for a peak indication on the meter. The slug adjustment screw is on the 0.5-kc detent chassis next to L1201.

(9) Repeat the adjustment of the trimmer capacitor of Z1201 at the high-frequency end of the dial and the adjustment of the slug of coil L1202 at the low-frequency end of the dial until no noticeable increase in peak indication is obtained. Do not readjust the tuning slug of Z1201.

k. Mixer Amplifier Alinement (fig. 139). For the following procedures, terminate the output of the modulator-oscillator group by connecting a 50-ohm, 1-watt resistor between J3809 (fig. 39, TM 11–5820–212–20) and ground. To check synchronization of gain frequency potentiometers R803 and R810, set the BAND control to 5, turn the FREQ-MC control clockwise, and check that the negative bias voltage at TP1808 or TP1908 goes to 0 just as the high end of the frequency range (32.3000 mc) is reached. Then set the FREQ-MC control to 24.3000 mc, and check that the bias voltage at TP2210 is 0. Refer to paragraph 128*c* if above voltages are not obtained.

(1) Use the CHANNEL, BAND, FREQ-MC, and FREQ-KC controls and set up the following frequencies on the automatic tuning system:

Caution: Always tighten the three wingnuts on the BAND, FREQ-MC, and FREQ-KC knobs before repositioning the CHANNEL selector.

Channel	Band	Dial reading (mc)
1	1	1.7000
2	1	3.7000
3	2	2.3000
4	2	4.3000
5	3	4.3000
6	3	8.3000
7	4	8.3000
8	4	16.3000
9	5	17.9000
10	5	29.1000

Note. Frequency settings of 3.7000 mc (band 1) and 4.3000 mc (band 2) do not appear on the indicator dial. To set these frequencies, turn the BAND control to band 3 and turn the FREQ-MC control to 8.3 mc. When BAND control is set to band 2 or 1, the frequency is automatically at 4.3000 mc and 3.7000 mc, respectively.

(2) Set the DB CARRIER ATTENUATION controls on the tsb modulator panel to the 0 positions.

(3) Set the NORM-OFF-BAL switch on the agc chassis to OFF, and adjust the agc bias potentiometer (R4513) (fig. 91) in the tsb modulator bias circuit by manually rotating the potentiometer drive gear to 10.

(4) Set the UPPER SIDEBAND and LOWER SIDEBAND selector switches on the tsb modulator panel to OFF.

(5) Connect the ME–26/U to TP4401 on the band switch chassis.

Note. When the steps in (6) through (11) below are performed, adjust the DB CARRIER ATTENUATION controls as the operating frequency is changed to maintain the RF output voltage at TP4401 at approximately 1 volt.

(6) For any of the mixer amplifier alinement procedures below, check the position of the slug racks as described in *d*(2) above. Adjust the cores of the tuning inductors while the subunit is tuned to the low-frequency end of the band, and then adjust the trimmer capacitors while the subunit is tuned to the high-frequency end of the band. Repeat the procedure for the low and high ends of the band until peak readings for each tuned circuit cannot be further increased. When two tank circuits are overcoupled, alinement of one tank circuit is accomplished with a Z2602 alinement tool connected to the other tank circuit. Select the indicated channel with the CHANNEL selector switch.

(7) Band 1 mixer amplifier (fig. 139):

Step	Channel	Swamping tool (Z2601) connected to	Adjust
1	1	TP1801 on Z1801	L1802 in Z1802
2	1	TP1802 on Z1802	L1801 in Z1801
3	1	TP1803 on Z1803	L1804 in Z1804
4	1	TP1804 on Z1804	L1803 in Z1803
5	1	TP1805 on Z1805	L1806 in Z1806
6	1	TP1806 on Z1806	L1805 in Z1805
7	1	TP1806 on Z1806	L1807 in Z1807
8	2	TP1801 on Z1801	C1808 in Z1802
9	2	TP1802 on Z1802	C1805 in Z1801
10	2	TP1803 on Z1803	C1817 in Z1804
11	2	TP1804 on Z1804	C1815 in Z1803
12	2	TP1805 on Z1805	C1827 in Z1806
13	2	TP1806 on Z1806	C1824 in Z1805
14	2	TP1806 on Z1806	C1834 in Z1807

(8) Band 2 mixer amplifier (fig. 139):

Step	Channel	Swamping tool (Z2601) connected to	Adjust
1	3	TP1901 on Z1901	L1902 in Z1902
2	3	TP1902 on Z1902	L1901 in Z1901
3	3	TP1903 on Z1903	L1904 in Z1904
4	3	TP1904 on Z1904	L1903 in Z1903
5	3	TP1905 on Z1905	L1906 in Z1906
6	3	TP1906 on Z1906	L1905 in Z1905
7	3	TP1906 on Z1906	L1907 in Z1907
8	4	TP1901 on Z1901	C1908 in Z1902
9	4	TP1902 on Z1902	C1905 in Z1901
10	4	TP1903 on Z1903	C1917 in Z1904
11	4	TP1904 on Z1904	C1915 in Z1903
12	4	TP1905 on Z1905	C1927 in Z1906
13	4	TP1906 on Z1906	C1925 in Z1905
14	4	TP1906 on Z1906	C1935 in Z1907

(9) Band 3 mixer amplifier (fig. 139):

Step	Channel	Swamping tool (Z2601) connected to	Adjust
1	5	TP2001 on Z2001	L2002 in Z2002
2	5	TP2002 on Z2002	L2001 in Z2001
3	5	TP2003 on Z2003	L2004 in Z2004
4	5	TP2004 on Z2004	L2003 in Z2003
5	5	TP2004 on Z2004	L2005 in Z2005
6	6	TP2001 on Z2001	C2006 in Z2002
7	6	TP2002 on Z2002	C2005 in Z2001
8	6	TP2003 on Z2003	C2015 in Z2004
9	6	TP2004 on Z2004	C2014 in Z2003
10	6	TP2004 on Z2004	C2023 in Z2005

(10) Band 4 mixer amplifier (fig. 139):

Step	Channel	Adjust
1	7	L2101 in Z2101
2	7	L2102 in Z2102
3	7	L2103 in Z2103
4	7	L2104 in Z2104
5	7	L2105 in Z2105
6	8	C2105 in Z2101
7	8	C2107 in Z2102
8	8	C2115 in Z2103
9	8	C2117 in Z2104
10	8	C2125 in Z2105

(11) Band 5 mixer amplifier (fig. 139):

Step	Channel	Adjust
1	9	L2201 in Z2201
2	9	L2202 in Z2202
3	9	L2203 in Z2203
4	9	L2204 in Z2204
5	9	L2205 in Z2205
6	10	C2205 in Z2201
7	10	C2207 in Z2202
8	10	C2215 in Z2203
9	10	C2217 in Z2204
10	10	C2225 in Z2205

132. Adjustment of Automatic Gain Control (fig. 91)

***Caution:* Do not attempt any of these adjustments before making certain that all other circuits are aligned.**

a. Tube V4501 Plate Circuit Alinement.

(1) Turn off power amplifier plate voltage. Modulator-oscillator plate voltage must be on.

(2) Set the DB CARRIER ATTENUATION controls to 0.

(3) Connect the ME–26/U dc probe to TP4503.

(4) Tune trimmer capacitor C4504, accessible through a hole in the top of the chassis, for maximum positive dc voltage at TP4503.

b. Dc Amplifier Balance.

(1) Leave power amplifier plate voltage off and modulator-oscillator plate voltage on.

(2) Set the NORM-OFF-BAL switch on the agc chassis to BAL.

(3) Turn SENSITIVITY control R4508 to its clockwise stop.

(4) Adjust BALANCE control R4511 so that the motor will not run when the gear train is in the midportion of its range.

(5) Set the NORM-OFF-BAL switch to NORM.

c. SENSITIVITY (R4508) and LEVEL (R4505) Adjustments (fig. 91).

(1) SENSITIVITY control R4508 adjusts the gain of the agc servosystem. The setting of this control depends upon the power amplifier (Radio Frequency Amplifier AM–1154A/G, TM 11–5820–350–35) requirements and should be just below the point at which hunting occurs.

(2) LEVEL control R4505 adjusts the point to which the agc automatically adjusts the gain of the signal path between the output of the tsb modulator and the point from which the agc reference is obtained in the power amplifier.

(3) Agc NORM-OFF-BAL switch S4501 is a double-pole, three-position switch on the front of the agc chassis. In the NORM position, it connects the agc for normal operation; in the OFF position, it disables the agc; and in the BAL position, it turns on the agc potentiometer drive motor and the meter tube and shorts the input to the meter tube to permit dc balance adjustment.

133. Adjustment of Power Amplifier Tuneup Carrier Reinsert Level

***Caution:* Do not attempt any of these adjustments before making certain that all other circuits are in alinement.**

For power amplifier tuneup purposes, the power amplifier has control of relays K201 and K202 in the tsb generator chassis. These relays remove any signal normally present and reinsert a carrier at an arbitrary level controlled by pa tuneup carrier reinsert level control R220 on the tsb generator chassis. During this operation, the output of the modulator-

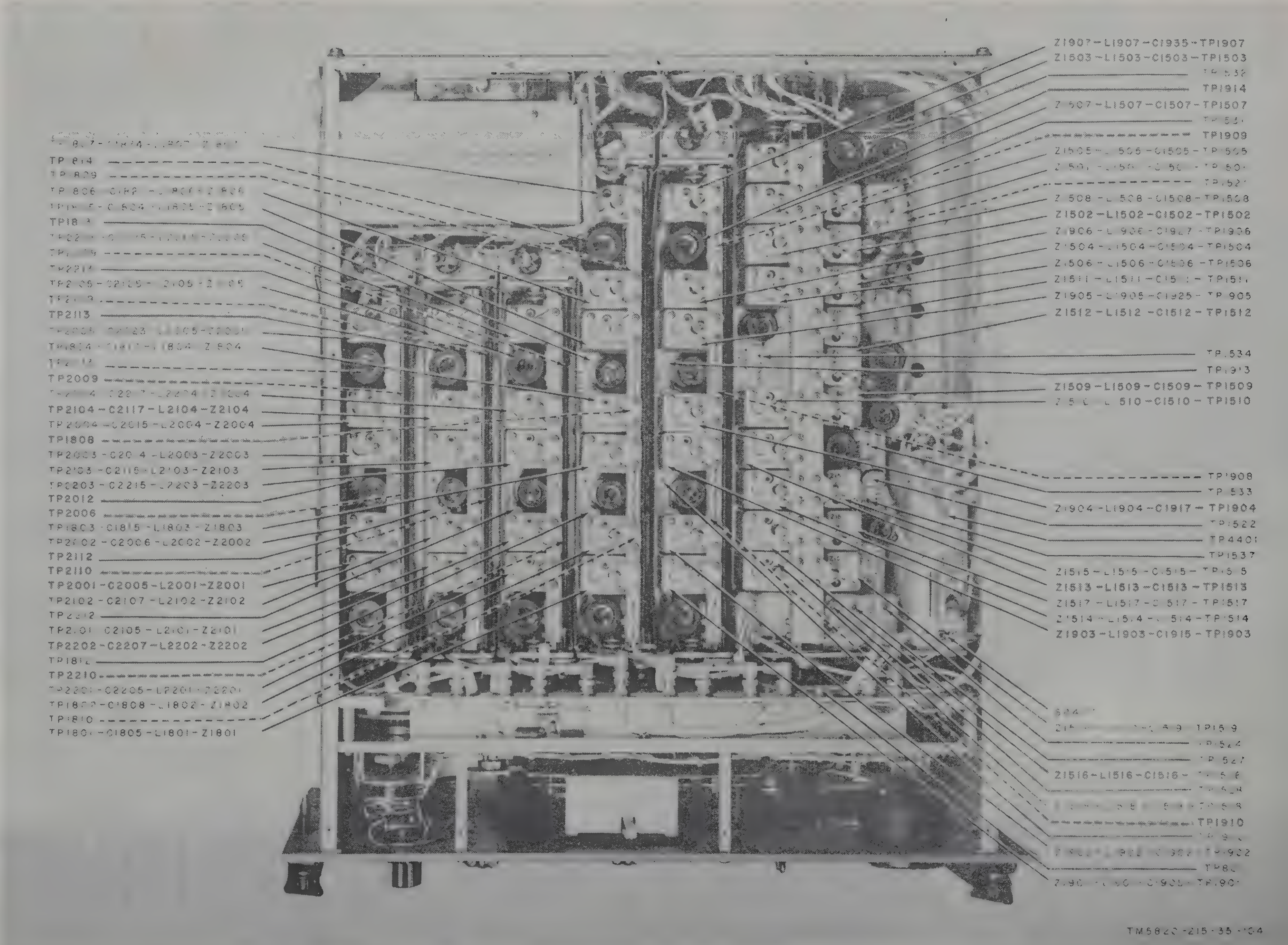


Figure 139. Exciter-monitor, alinement points.

oscillator group is still under the protective control of agc and alc. The adjustment of R220 is determined by the requirements of the power amplifier. When this modulator-oscillator group is used as the exciter for Radio Frequency Amplifier AM–1154A/G, refer to paragraph 73*k* of TM 11–5820–350–35 for alinement instructions.

134. Neutralization of Bands 1, 2, and 3, Mixer Amplifiers

(figs. 103 and 140)

a. General. The mixer amplifiers for bands 1 through 3 are neutralized at the factory and require *no* further neutralization unless a neutralizing capacitor (C1829, C1930, or C2020) is replaced, or its setting is disturbed, or one of the bridge capacitors C1826, C1929, or C2017 is replaced. The mixer amplifiers for bands 4 and 5 require no neutralization.

***Caution:* Do not disturb the setting of neutralizing capacitor C1829, C1930, or C2020 until all other possible causes of trouble have been eleminated. Make certain that all circuits of the modulator-oscillator group are properly aligned before attempting the neutralizing procedure described below.**

b. Neutralization of Band 1 Mixer Amplifier.

(1) Remove the mixer amplifier from the exciter-monitor chassis (par. 123*i*); leave all power and coaxial cables connected.

(2) Support the mixer amplifier so that neutralizing capacitor C1829 on the side of the unit is accessible.

(3) Block the slug rack so that the bottom of the slug rack is 1 inch from the top of the coil covers.

(4) Energize the modulator-oscillator group and tune the exciter-monitor to 3.7000 mc.

(5) Adjust only the cores of the tuning inductors for maximum voltage at TP4401; use the Z2601 swamping tool as directed in the chart in paragraph 131*k*(7), steps 1 through 7.

(6) Disconnect P850 from J1802, P1802 from J825, P1801 from J826 and connect the rf meter (par. 111) to J1802.

(7) Connect the receiver antenna to TP1809; use the probe as described in paragraph 131*f*(3).

(8) Inject a 3.7000-mc signal from the rf meter at a level of approximately 2 volts.

(9) Tune the receiver to 3.7000 mc (tune for a maximum indication on the carrier level meter of the receiver), and adjust neutralizing capacitor C1829 for minimum reading on the carrier level meter.

(10) Remove the test equipment, reconnect P850 to J1802, P1802 to J825, P1801 to J826, and replace the mixer amplifier as directed in paragraph 122*j*.

(11) Perform the alinement procedure described in paragraph 131*k*(1) through (7).

c. Neutralization of Band 2 Mixer Amplifier.

(1) Remove the mixer amplifier from the exciter-monitor chassis (par. 123*i*); leave all power and coaxial cables connected.

(2) Support the mixer amplifier so that neutralizing capacitor C1930 on the side of the unit is accessible.

(3) Block the slug rack so that the bottom of the slug rack is 1 inch from the top of the coil covers.

(4) Energize the modulator-oscillator group and tune the exciter-monitor to 4.3000 mc.

(5) Adjust only the cores of the tuning inductors for maximum voltage at TP4401; use the Z2601 swamping tool as directed in the chart in paragraph 131*k*(8), steps 1 through 7.

(6) Disconnect P851 from J1902, P1902 from J827, F1901 from J828, and connect the RF meter to J1902.

(7) Connect the receiver antenna to TP1909; use the probe as described in paragraph 131*f*(3).

(8) Inject a 4.3000-mc signal from the RF meter at a level of approximately 2 volts.

(9) Tune the receiver to 4.3000 mc (tune for a maximum indication on the carrier level meter of the receiver), and adjust neutralizing capacitor C1930 for a minimum indication on the carrier level meter.

(10) Remove the test equipment and reconnect P851 to J1902, P1902 to J827, P1901 to J828, and replace the mixer amplifier as directed in paragraph 123*j*.

(11) Perform the alinement procedure described in paragraph 131*k*(1) through (8), omitting (7).

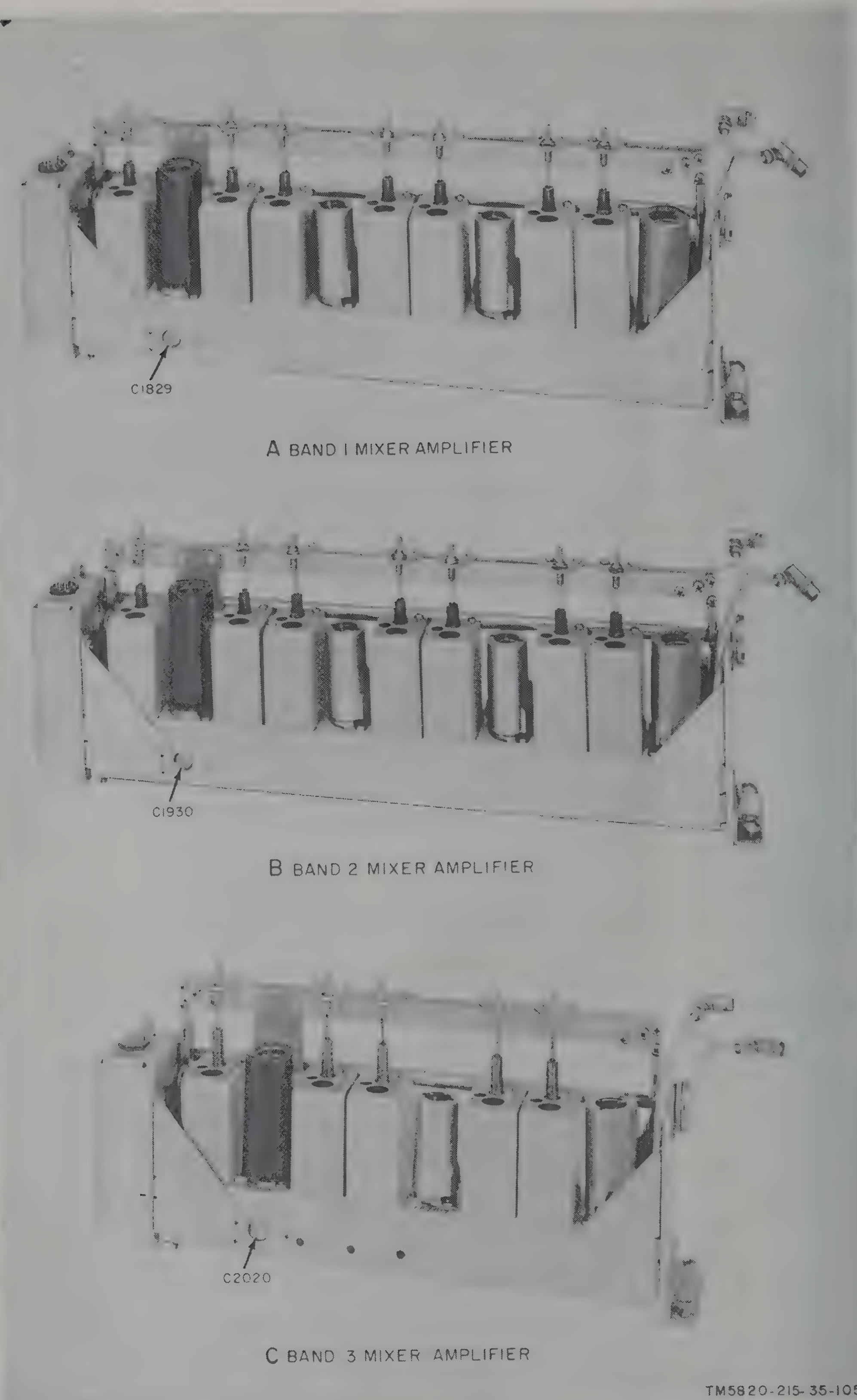


Figure 140. Bands 1 through 3 mixer amplifier, neutralizing capacitor location.

d. Neutralization of Band 3 Mixer Amplifier.

(1) Remove the mixer amplifier from the exciter-monitor chassis as directed in paragraph 123*i*; leave all power and coaxial cables connected.

(2) Support the mixer amplifier so that neutralizing capacitor C2020 on the side of the subchassis is accessible.

(3) Block the slug rack so that the bottom of the slug rack is 1 inch from the top of the coil covers.

(4) Energize the modulator-oscillator and tune the exciter-monitor to 8.3000 mc. Perform the steps in paragraph 131*k*(2) through (6).

(5) Adjust only the cores of the tuning inductors for maximum voltage at TP4401; use the Z2601 swamping tool as directed in the chart in paragraph 130*k*(10), steps 1 through 7.

(6) Disconnect P852 from J2002, P2002 from J829, P2001 from J830, and connect the RF meter to J2002.

(7) Connect the receiver antenna to TP2009; use the probe as described in paragraph 131*f*(3).

(8) Inject an 8.3000-mc signal from the RF meter at a level of approximately 2 volts.

(9) Tune the receiver to 8.3000 mc (tune for maximum indication on the receiver carrier level meter), and adjust neutralizing capacitor C2020 for a minimum indication on the receiver carrier level meter.

(10) Remove the test equipment and reconnect P852 to J2002, P2002 to J829, P2001 to J830, and replace the mixer amplifier as directed in paragraph 123*j*.

(11) Perform the alinement procedure described in paragraph 131*k*(1) through (9), omitting (7) and (8).

135. Phase Lock Indicator Adjustment

(figs. 104, 105 and 125)

a. Tune the exciter-monitor to 16.3000 mc on band 5.

b. Turn the front-panel 0.5 KC LOCK switch to OFF.

c. Make sure that the smo is phase locked. (If the smo is not phase locked, relay K4806 is deenergized and an ac error voltage appears at TP4803.)

d. Set IND ADJ switch S4801 (on the phase lock indicator chassis) to ADJ.

e. Turn R1749, R1750, and R4808 counterclockwise to their stops.

f. Turn R1749 clockwise until the dc voltage at TP4804 stops increasing, then turn R1749 counterclockwise to reduce this voltage by 0.1 volt.

g. Turn R1750 clockwise to obtain +3 volts at TP4805.

h. Slowly turn R4808 clockwise until the blue STABILIZED light is energized.

i. Set IND ADJ switch S4801 to NORM.

Section III. LUBRICATION

136. General

a. Most of the bearings, gears, and other mechanical parts of Modulator-Oscillator Group OA–2180/FRT–51 require no lubrication other than that performed at the factory. The only components that require periodic lubrication are the chains, sprockets, and gears forming the exciter-monitor automatic tuning drive mechanism and the automatic tuning positioning and control heads. Lubrication of the automatic tuning drive mechanism is described in paragraph 138. Lubrication of the positioning and control heads is described in paragraphs 139 through 141. Both these procedures should be performed semiannually, or after 10,000 automatic tuning cycles, whichever occurs first. The lubrication chart (par. 137) shows the lubrication procedures to be followed. Letter designations on the charts and illustrations specify the type of lubricant and general manner of lubrication for each part.

b. Inspect all exterior items periodically for signs of rust, corrosion, or wear. If lubrication is required, apply oil or grease, as applicable, in accordance with the instructions in the lubrication chart (par. 137). Typical exterior items are listed below:

(1) Drawer slides.

(2) Drawer positioning pins.

(3) Drawer out position latches.

(4) Drawer pivot pins and locking pins.

(5) Cable support bracket hinges.

c. Be sure that lubricants and the parts to be lubricated are clean. Sand, grit, and dirt are the major cause of bearing wear. Do not use excessive amounts of lubricant. Overlubrication can cause damage to the equipment.

137. Lubrication Chart

Letter designation	Types of lubricant	Special instructions
A	Lubricating oil, general purpose (OGP), MIL–L–7870.	(1) *Bearings.* Clean with Cleaning Compound and apply oil sparingly. Wipe off all excess. (2) *Other components.* Clean with Cleaning Compound and apply lubricant sparingly. Wipe off all excess.
B	Grease, aircraft and instruments (GL), MIL–G–3278.	(1) *Gears and sprockets.* Clean with Cleaning Compound and apply a thin, even film of grease to tooth faces only. (2) *Chains.* Clean the chain with Cleaning Compound and apply a thin, even film of grease to entire chain; follow the directions in the accompanying paragraph. (3) *Ball bearings.* Clean entire bearing with Cleaning Compound Pack bearing with grease, wipe off excess, and replace bearing.

138. Automatic Tuning Drive Mechanism Lubrication

(fig. 141)

a. Remove the exciter-monitor front panel (par. 123*n*).

b. Remove the band switch automatic positioning head (par. 124*c*).

c. Remove the automatic tuning control head (par. 124*e*).

d. Remove the frequency counter dial assembly (par. 124*k*).

e. Refer to figure 141. All the automatic drive mechanism components are lubricated with grease (OGP), designated B. Apply lubricant to all designated components. To lubricate most of these components properly, turn the drive mechanism slowly while brushing on the lubricant. To turn the mechanism, rotate the manual drive pinion by using the special crank (H2609).

f. Replace the frequency counter dial assembly (par. 124*l*).

g. Replace the automatic tuning control head (par. 124*f*).

h. Replace the band switch automatic positioning head (par. 124*d*).

i. Replace the exciter-monitor front panel (par. 123*o*).

139. Frequency-Mc and Frequency-Kc Positioning Heads Lubrication

(figs. 142 and 143)

Partial disassembly of the positioning heads is required during the lubrication procedure. Do *not* disassemble the heads further than described in this procedure.

a. Remove the frequency-mc and frequency-kc positioning heads (par. 124*a*).

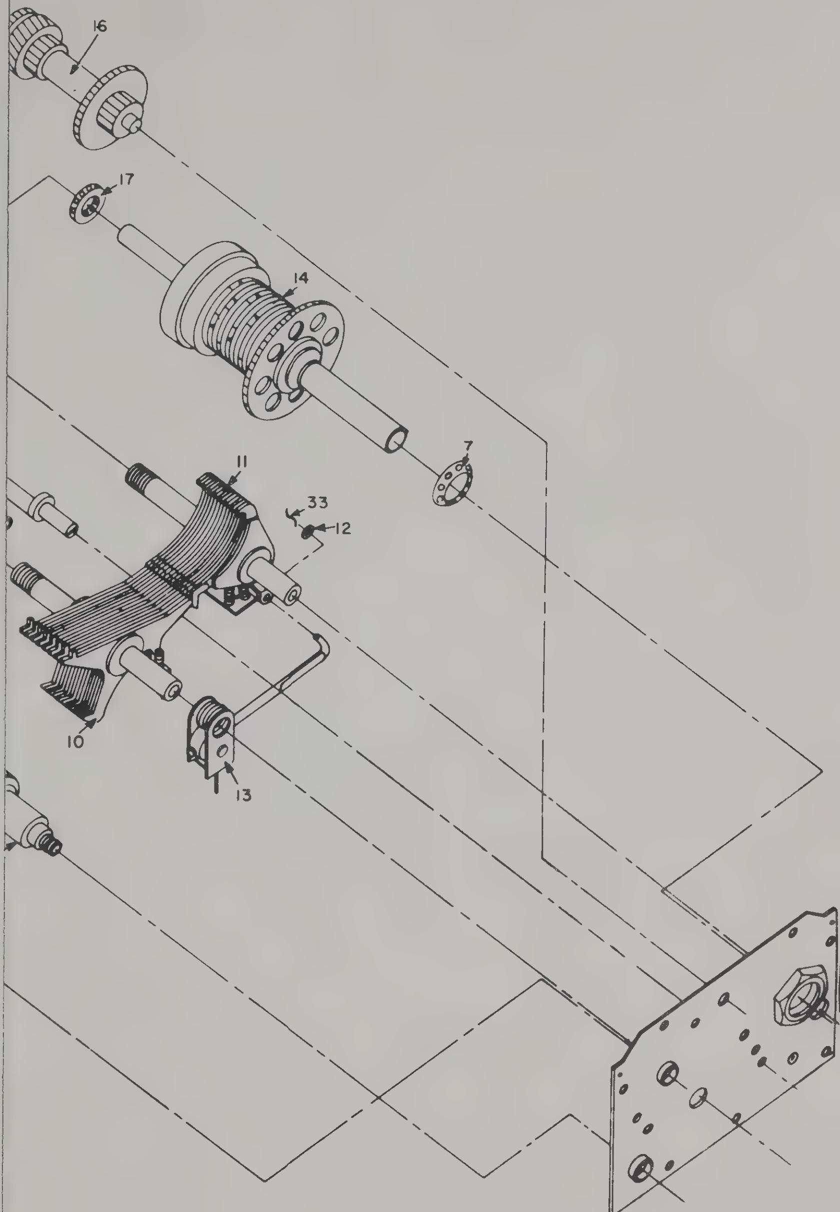
b. The steps in *c* through *r* below describe disassembly and reassembly of the positioning heads, as necessary to lubricate the ball bearings. The instructions given are for one head only because the disassembly and reassembly procedures for both heads are identical. Refer to figure 142 for component identification.

c. Remove the dust covers (27, 28, and 30) from the top and sides of the head.

d. Remove the cam drum nut (4); prevent the cam drum drive gear assembly (9) shaft from rotating by inserting a No. 10 Bristo wrench in the Bristo socket in the end of the shaft. The cam drum nut on this head has a left-hand thread.

e. Remove the safety wires (33) from the heads of the spring anchor screws (32). Loosen the screws to relax the springs, but do *not* remove them.

f. Remove all front plate assembly screws (1) and lockwashers (2).



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mbly

(5) Cable support bracket hinges.

c. Be sure that lubricants and the parts to be lubricated are clean. Sand, grit, and dirt are the major cause of bearing wear. Do not use excessive amounts of lubricant. Overlubrication can cause damage to the equipment.

137. Lubrication Chart

Letter designation	Types of lubricant	Special instructions
A	Lubricating oil, general purpose (OGP), MIL–L–7870.	(1) *Bearings.* Clean with Cleaning Compound and apply oil sparingly. Wipe off all excess. (2) *Other components.* Clean with Cleaning Compound and apply lubricant sparingly. Wipe off all excess.
B	Grease, aircraft and instruments (GL), MIL–G–3278.	(1) *Gears and sprockets.* Clean with Cleaning Compound and apply a thin, even film of grease to tooth faces only. (2) *Chains.* Clean the chain with Cleaning Compound and apply a thin, even film of grease to entire chain; follow the directions in the accompanying paragraph. (3) *Ball bearings.* Clean entire bearing with Cleaning Compound Pack bearing with grease, wipe off excess, and replace bearing.

138. Automatic Tuning Drive Mechanism Lubrication

(fig. 141)

a. Remove the exciter-monitor front panel (par. 123*n*).

b. Remove the band switch automatic positioning head (par. 124*c*).

c. Remove the automatic tuning control head (par. 124*e*).

d. Remove the frequency counter dial assembly (par. 124*k*).

e. Refer to figure 141. All the automatic drive mechanism components are lubricated with grease (OGP), designated B. Apply lubricant to all designated components. To lubricate most of these components properly, turn the drive mechanism slowly while brushing on the lubricant. To turn the mechanism, rotate the manual drive pinion by using the special crank (H2609).

f. Replace the frequency counter dial assembly (par. 124*l*).

g. Replace the automatic tuning control head (par. 124*f*).

h. Replace the band switch automatic positioning head (par. 124*d*).

i. Replace the exciter-monitor front panel (par. 123*o*).

139. Frequency-Mc and Frequency-Kc Positioning Heads Lubrication

(figs. 142 and 143)

Partial disassembly of the positioning heads is required during the lubrication procedure. Do *not* disassemble the heads further than described in this procedure.

a. Remove the frequency-mc and frequency-kc positioning heads (par. 124*a*).

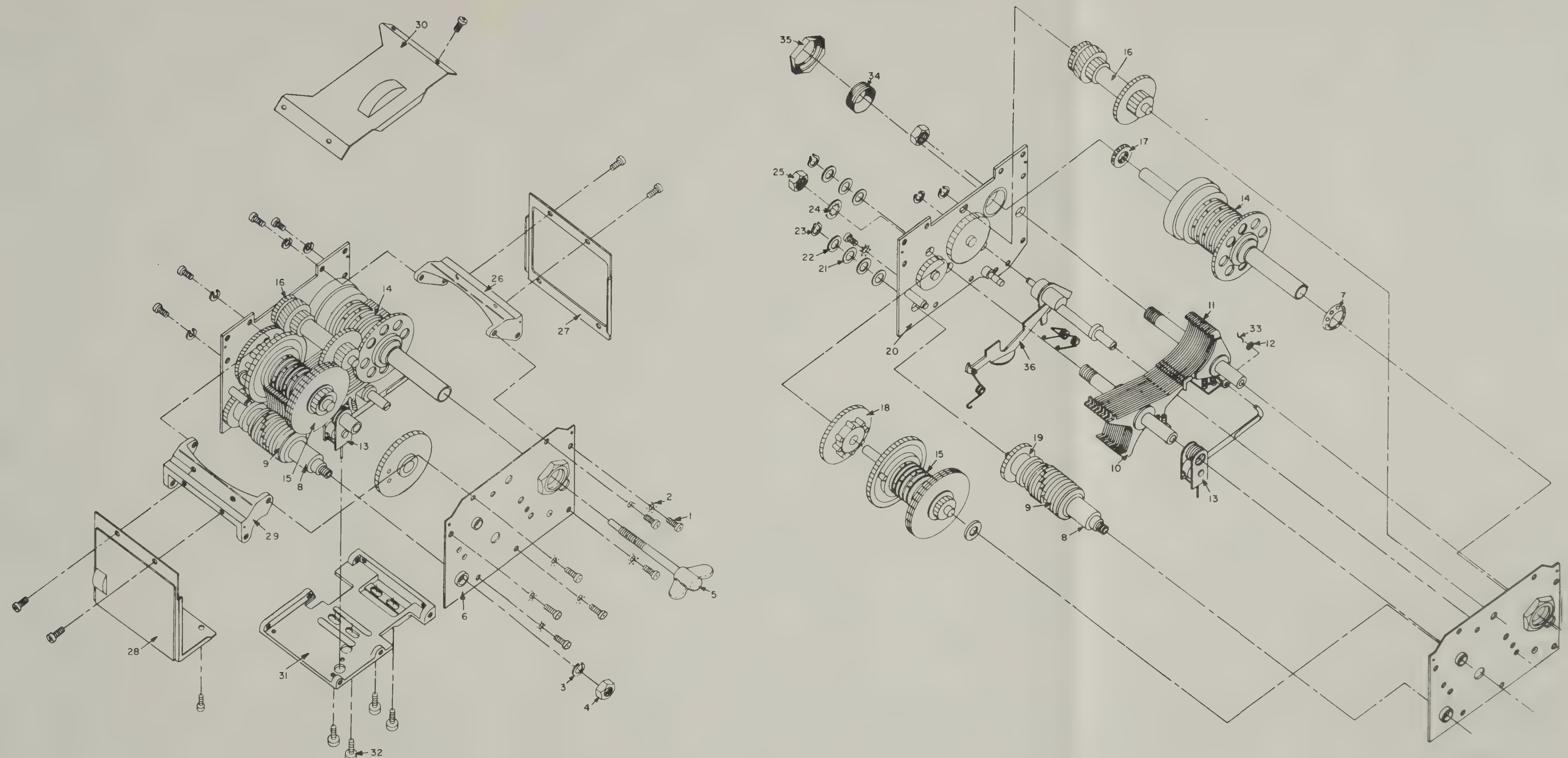
b. The steps in *c* through *r* below describe disassembly and reassembly of the positioning heads, as necessary to lubricate the ball bearings. The instructions given are for one head only because the disassembly and reassembly procedures for both heads are identical. Refer to figure 142 for component identification.

c. Remove the dust covers (27, 28, and 30) from the top and sides of the head.

d. Remove the cam drum nut (4); prevent the cam drum drive gear assembly (9) shaft from rotating by inserting a No. 10 Bristo wrench in the Bristo socket in the end of the shaft. The cam drum nut on this head has a left-hand thread.

e. Remove the safety wires (33) from the heads of the spring anchor screws (32). Loosen the screws to relax the springs, but do *not* remove them.

f. Remove all front plate assembly screws (1) and lockwashers (2).



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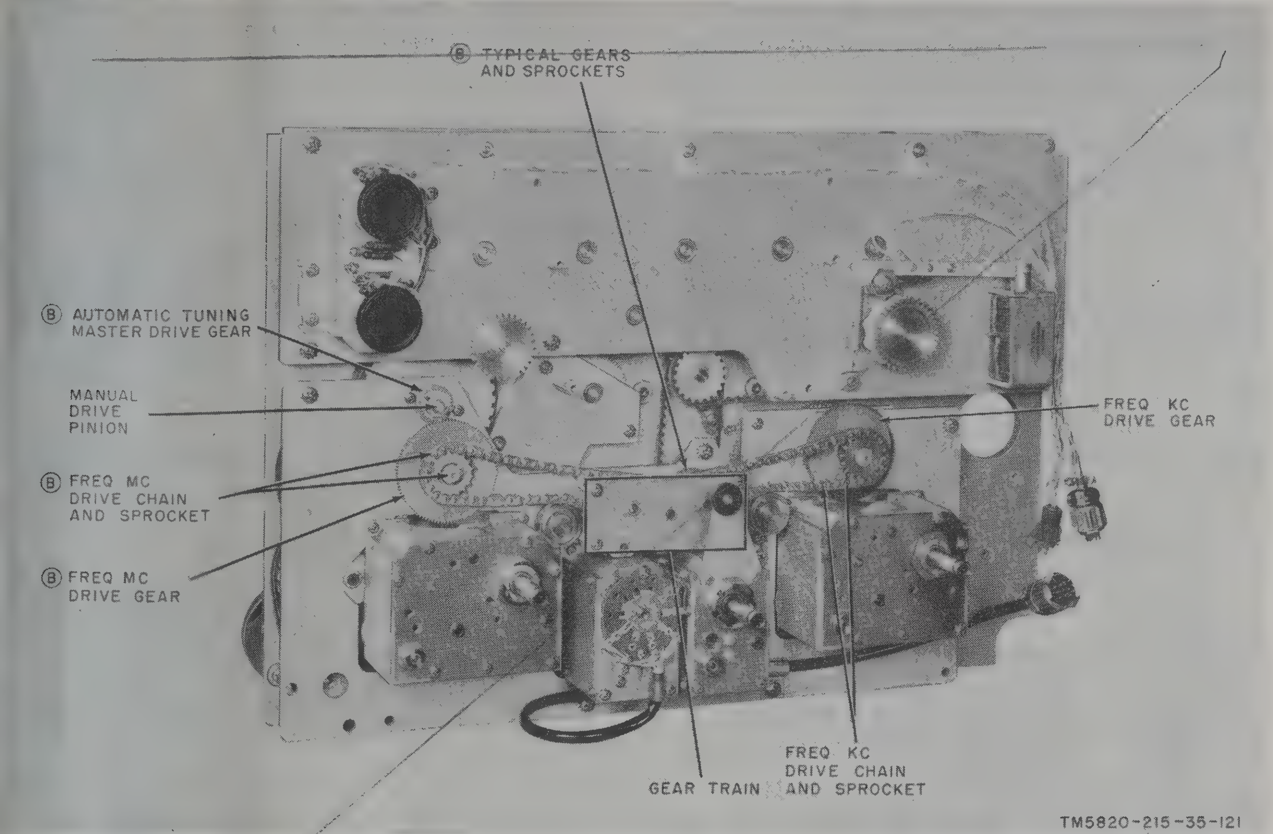
1 Screw
2 Lockwasher
3 Split lockwasher
4 Cam drum nut
5 Locking wingnut 0899.173 (Added) see C3
6 Front plate assembly
7 Ball bearing
8 Cam drum shaft collar
9 Cam drum drive gear assembly
10 Cam drum drive gear
11 Detent positioning lever
12 Flat washer
13 Catch pawl
14 Stop ring shaft assembly includes 0899.126, 0899.145, 0899.139 (Added) see C3
15 Positioning head assembly
16 Drive shaft assembly 0899.163 (Added) see C3
17 Ball bearings
18 Drive gear
19 Cam drum drive gear
20 Rear plate assembly
21 Flat washer
22 Flat washer
23 Split lockwasher
24 Lockwasher
25 Positioning head nut
26 Upper right standoff assembly
27 Dust cover
28 Dust cover
29 Upper left standoff assembly
30 Dust cover
31 Bottom plate assembly
32 Spring anchor screws
33 2-inch length of safety wire
34 Threaded bushing
35 Retaining nut
36 Detent positioning pawl assembly

Figure 142. Frequency-mc and frequency-kc positioining heads, exploded view.

Sup
C3



~~*Figure 141. Automatic tuning drive mechanism, lubrication.*~~

g. Carefully remove the front plate assembly (6).

h. Remove the assembly screws that hold the upper right standoff assembly (26) to the backplate. Remove the upper right standoff assembly.

i. Grasp the drive shaft on the stop ring shaft assembly (14). Tilt the assembly upward and to the right, and work it free of the main assembly. Be extremely careful not to damage the drive shaft assembly (16) gears. Do not disassemble the main assembly any further.

j. Remove the ball bearings (7 and 17) from the front and rear of the stop ring shaft assembly (14).

k. Clean the entire stop ring shaft assembly with cleaning compound.

***Caution:* Do not permit lubricant or cleaning compound to flow into the slip clutch on the rear of the stop ring shaft assembly (14).**

l. With the stop ring shaft assembly removed (14), clean the remainder of the main assembly thoroughly with cleaning compound.

m. Clean the ball bearings (7 and 17) with cleaning compound and repack them with grease (GL). Replace the ball bearings on the stop ring shaft assembly (14), and reinstall.

n. Replace the upper right standoff assembly (26).

o. Work the various shafts into position on the front plate assembly (6) until the plate snaps into position. Do not force or deform the plate while positioning it.

p. Replace all front plate assembly screws (1) and lockwashers (2).

q. Relock the spring anchor screws (32) by using 2-inch lengths of No. 22 safety wire (33). Make loops in a figure-of-eight through the heads of each pair of screws, and twist the ends of each wire together.

r. Remove the No. 10 Bristo wrench in the Bristo socket of the cam drum drive gear assembly (9) shaft. Replace the cam drum nut (4) without disturbing the position of the shaft.

s. Refer to figure 143. Lubricate all components indicated on the illustration; use the special instructions in the lubrication chart (par. 137) as a guide.

t. Replace the dust covers (27, 28, and 30).

u. Replace the frequency-mc and frequency-kc positioning heads (par. 124*b*).

140. Band Switch Positioning Head Lubrication

(figs. 144 and 145)

This paragraph describes the procedure for disassembly and reassembly of the band switch positioning head, as necessary to lubricate the two ball bearings. Refer to figure 144 for component identification.

a. Refer to paragraph 124*c* and remove the band switch positioning head.

b. Remove the dust covers and plates (27 and 29) from the sides and bottom of the head.

c. Remove the cam drum nut (4). Insert a No. 10 Bristo wrench within the socket in the end of the cam drum drive gear assembly (15) shaft to prevent the shaft from rotating. The cam drum nut (4) has right-hand threads.

d. Remove the safety wire (26) from the heads of the spring anchor screws (25). Loosen the screws to relax the springs, but do not remove them.

e. Remove all front plate assembly screws (1) and lockwashers (2).

f. Carefully remove the front plate assembly (6).

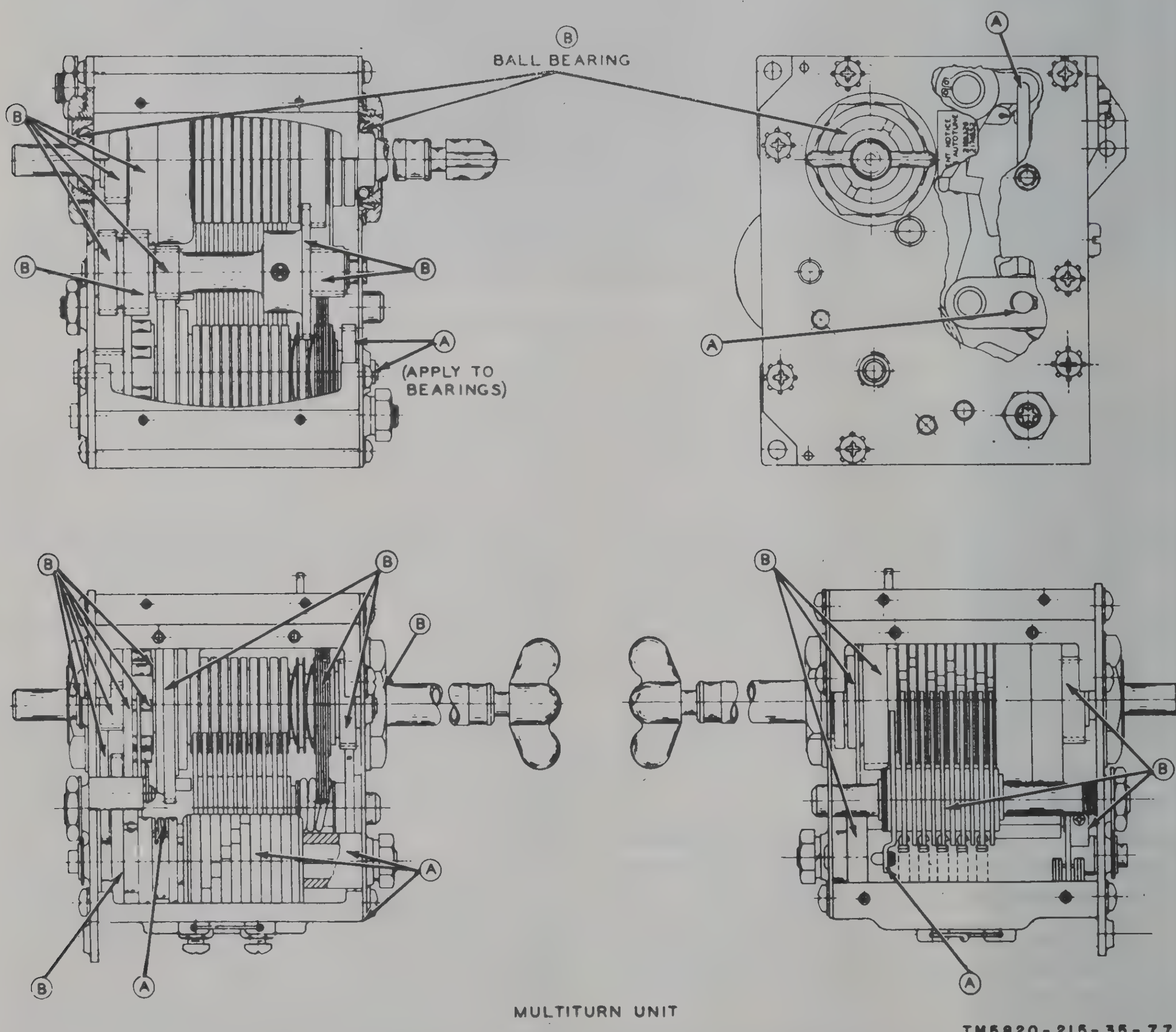


Figure 143. Frequency-mc and frequency-kc positioning heads, lubrication.

g. Remove the assembly screws and split washers (22) that hold the upper bearing plate standoff (23) to the rear plate assembly (16). Remove the upper bearing plate standoff.

h. Grasp the drive shaft on the stop ring shaft assembly (12). Tilt the assembly up and to the left, and work it free of the main assembly. Do *not* disassemble the main assembly any further.

i. Remove the ball bearings (11 and 14) from the front and rear of the stop ring shaft assembly (12).

j. Clean the entire stop ring shaft assembly with solvent (SD).

***Caution:* Do not permit lubricant or solvent to flow into the slip clutch on the rear of the stop ring shaft assembly.**

k. With the stop ring shaft assembly removed, clean the remainder of the main assembly thoroughly with cleaning compound.

l. Clean the ball bearings (11 and 14) with cleaning compound, and pack them with grease (GL). Replace the ball bearings on the stop ring shaft assembly. Replace the assembly.

m. Replace the upper bearing plate standoff (23).

n. Work the various shafts into position on the front plate assembly (6) until the plate snaps into position. Do not force or deform the plate while positioning it.

o. Replace all front plate assembly screws (1) and lockwashers (2).

p. Replace and relock the spring anchor screws (25) by using a 2-inch length of No. 22 safety wire (26). Make loops in a figure-of-eight through the heads of the screws, and twist the ends of each wire together.

q. Remove the No. 10 Bristo wrench from the socket in the end of the cam drum drive gear assembly (15) shaft. Hold the shaft to prevent movement and replace the cam drum nut (4).

r. Refer to figure 145. Lubricate all components indicated on the illustration; use the special instructions in the lubrication chart (par. 137).

s. Replace the dust covers (27) and plates (29).

t. Replace the band switch positioning head (par. 124*d*).

141. Automatic Tuning Control Head Lubrication
(fig. 146)

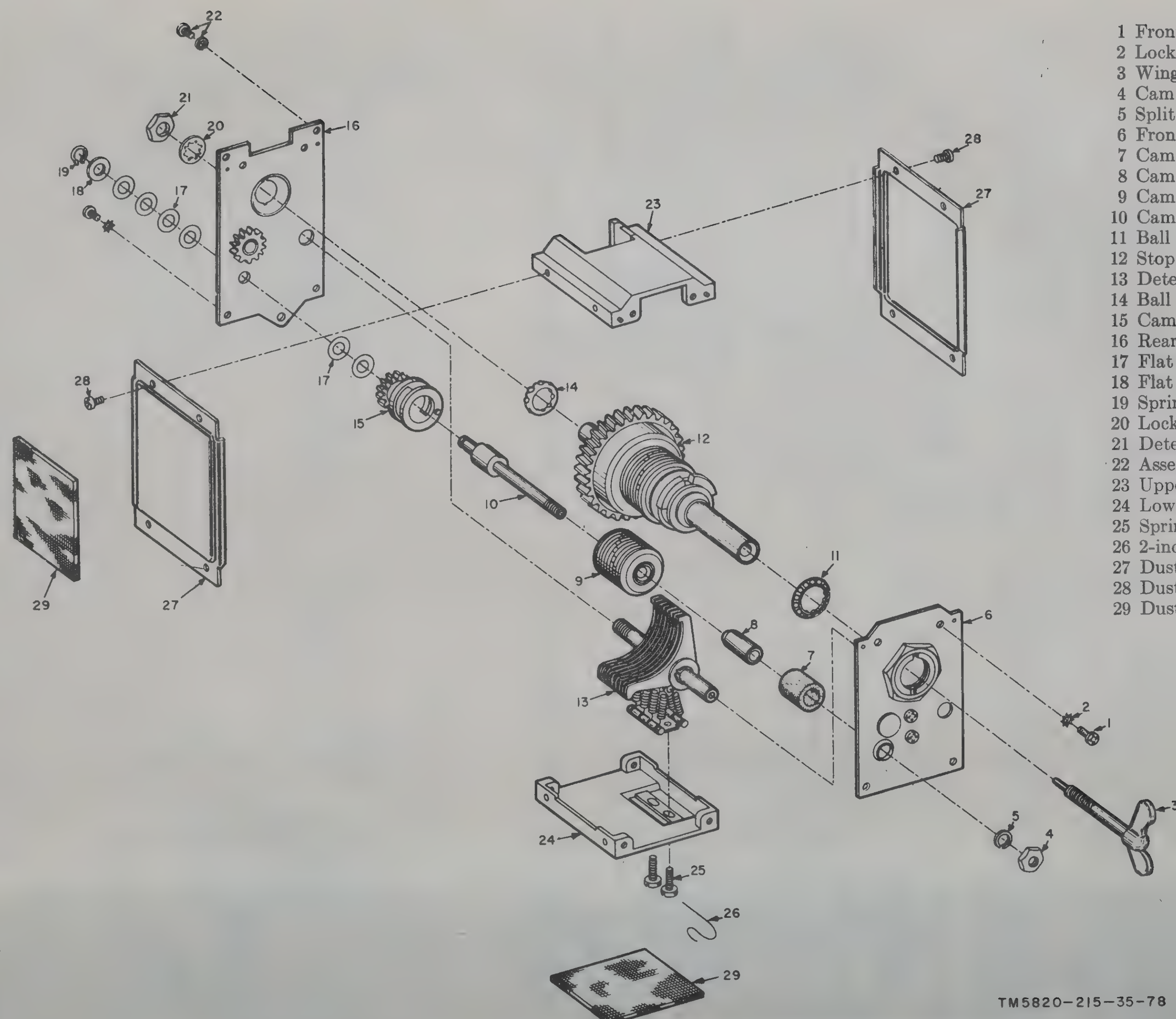
a. Refer to paragraph 124*e* and remove the control head.

b. Remove the dust covers from the sides of the control head.

c. Refer to figure 146. Lubricate all components indicated on the illustration; follow the special instructions in the lubrication chart (par. 137) as a guide. Do *not* disassemble the head.

d. Replace the control head in the main frame (par. 124*f*).

e. Synchronize the automatic tuning system (par. 128*a*).



1 Front plate assembly screw
2 Lockwasher
3 Wingnut 0899.119 (Added) See C3
4 Cam drum nut
5 Split lockwasher
6 Front plate assembly
7 Cam drum shaft collar
8 Cam drum coupler
9 Cam drum positioning washers
10 Cam drum shaft
11 Ball bearings
12 Stop ring shaft assembly (includes 0898.2?) See C3 (Added)
13 Detent positioning lever
14 Ball bearings
15 Cam drum drive gear assembly
16 Rear plate assembly
17 Flat washer
18 Flat spacer
19 Spring lock
20 Lockwasher
21 Detent positioning lever nut
22 Assembly screw and split washer
23 Upper bearing plate standoff
24 Lower bearing plate standoff
25 Spring anchor screw
26 2-inch length of safety wire
27 Dust cover
28 Dust cover screw
29 Dust cover plate

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Figure 144. Band switch positioning head, exploded view.

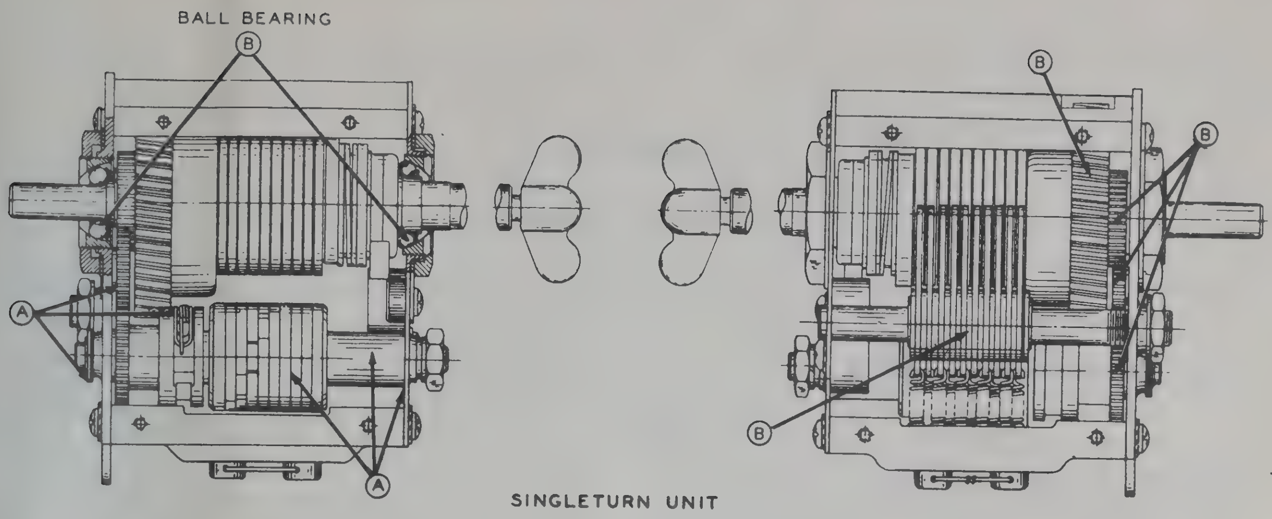


Figure 145. Band switch positioning head, lubrication.

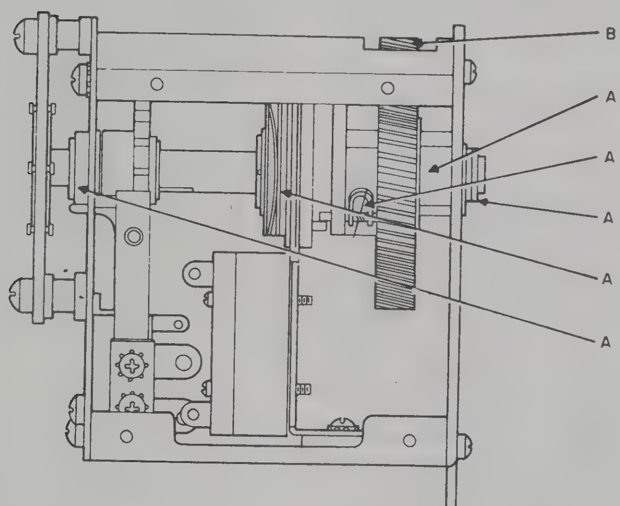


Figure 146. Automatic tuning control head, lubrication points.

CHAPTER 8

FINAL TESTING

142. Purpose of Final Testing

Paragraphs 144 through 148 are to be used as a guide in determining the quality of a repaired modulator-oscillator. Repaired equipment that meets these requirements will provide satisfactory operation, equivalent to that of new equipment. If the equipment fails to meet the performance standards determined by the tests, refer to applicable troubleshooting procedures in chapter 6.

Note. Before conducting the final tests, refer to paragraphs 125 through 135 and check the adjustment and alignment of the equipment. Adjust and aline as necessary.

143. Test Equipment Required for Final Testing

In addition to the test equipment listed for troubleshooting (par. 111) and alinement (par. 126), Panoramic Indicator IP–259/U is required.

144. Overall Performance Test

Modulator-Oscillator Group OA–2180/FRT–51 is designed for use as an ssb or tsb exciter for Radio Frequency Amplifier AM–1154A/G (covered in TM 11–5820–350–35) which is part of Radio Transmitting Set AN/FRT–51. The overall performance test for ssb and tsb service when the modulator-oscillator is used as part of Radio Transmitting Set AN/FRT–51 is in paragraph 78 of TM 11–5820–350–35.

145. Final Test Conditions

The standard test conditions listed below will be used for all final testing procedures.

a. Line Voltage. 115 volts ±15%, single-phase.

b. Line Frequency. 60 cps ±1 cycle.

c. Warmup Period. The crystal oven should be on for at least 1 hour prior to conducting any tests.

d. Output Load. Connect to Radio Frequency Amplifier AM–1154A/G or into a 50-ohm resistive load.

e. Alc Switch. Set to OFF.

f. Agc Switch. Set to NORM.

g. Test Signal. The test input signal should be a two-tone test signal of 3- and 5-kc tones of equal amplitudes, the sum of which should indicate zero on the front-panel meter when the corresponding meter switch is in the +6-db position.

h. DB CARRIER ATTENUATION Controls. Set to maximum (fully counterclockwise).

i. REMOTE-LOCAL Switch. If the remote control unit (TM 11–5821–212–10) is used, set the REMOTE-LOCAL switch on Radio Frequency Amplifier AM–1154A/G to LOCAL.

j. 0.5 KC LOCK Switch. Set to ON.

k. Standard Test Frequencies. Set the 10 channels of the exciter-monitor to the ten frequencies listed below:

Channel	Band	Frequency-mc	Frequency-kc
1	1	1.7	000
2	1	3.7	000
3	2	2.3	000
4	2	4.3	000
5	3	4.3	000
6	3	8.3	000
7	4	8.3	000
8	4	16.3	000
9	5	16.3	000
10	5	30.0	000

l. Agc Setting. Manually adjust agc potentiometer R4516 to provide an output of 0.1 watt peak envelope power with a standard two-tone audio input signal as follows:

(1) Apply one tone to the input of the tsb modulator.

(2) Connect a 50-ohm resistor between P3809 and ground (output of exciter-monitor).

(3) Adjust R4516 until the voltage drop across the 50-ohm resistor (as measured with a ME–30B/U) is 1.11 volts.

146. Tuning Mechanism Preliminary Test

a. Automatic Tuning. Before applying power, unlock the automatic tuning mechanism (loosen the wingnuts on the BAND, FREQ-MC, FREQ-KC knobs) and manually tune through the entire range of FREQ-KC, FREQ-MC, and BAND dials. Check that nothing binds and that there is at least 1/4 turn of overtravel on the FREQ-KC and FREQ-MC dials.

b. Interpolator Synchronization. Set the FREQ-KC dial on 000. Unlock the FREQ-MC and BAND wingnuts. Check synchronization of interpolator by rotating band switch through all five positions while watching the FREQ-MC knob for movement. No movement of FREQ-MC knob indicates synchronization.

147. Power Control Circuits Tests

a. Standby Test. Turn the LINE switch to ON. The amber LINE indicator lamp should light. No blown-fuse indicators should be lighted. The meter on the automatic line voltage control panel should indicate 115 volts. The meter on the power supply front panel should indicate within the green area with the meter switch on position 4: +300V FREQ. STD., and position 5: +150V FREQ. STD. For all other positions of this meter, no indication should be obtained. The meter on the front panel of the exciter-monitor compartment should show no indication on any position of the METER SWITCH. The meter on the frequency standard compartment should show an indication on all 12 positions.

b. Filament and Plate Control Circuits Tests.

(1) *FILAMENT ON button.* When the FILAMENT ON button is pressed, the green FILAMENT indicator lamp should light, and the blower should operate. No blown-fuse indicators should light. The meter on the power supply compartment should indicate within the green area with the meter switch in positions 1, 2, 4, 5, and 8.

(2) *FILAMENT OFF button.* When this button is pressed, the equipment should revert to the standby condition.

(3) *PLATE ON button.* With the FILAMENT OFF button pressed, press the PLATE ON button. No effect should be observed. Press both FILAMENT ON and PLATE ON buttons. At first, only the conditions noted in (1) above should be observed. After 25 seconds (±5 seconds) the plate power should come on and the red PLATE ON indicator lamp should light. A few seconds later the blue STABILIZED lamp should light. No blown-fuse indicators should be lighted. The power supply front-panel meter should indicate in the green area for all positions of the meter switch.

148. Fusing Test

a. Blown-Fuse Indicators. Remove blown-fuse indicators one at a time and reinsert each into its holder with the fuse removed. The blown-fuse indicator should light.

Note. Because of interlocking circuits, tests of more than one blown-fuse indicator at the same time will result in one or more indicators not lighting.

b. MAIN PLATE Fuse. Remove the MAIN PLATE fuse; the red PLATE indicator lamp should go out.

c. RECTIFIER FILAMENT Fuse. With the FILAMENT and PLATE power buttons set at ON, remove the RECTIFIER FILAMENT fuse. The time-delay relay should drop out immediately, shutting off the plate power and the red PLATE indicator lamp. Replace the RECTIFIER FILAMENT fuse.

149. Automatic Tuning Operational Test

a. With the 10 channels of the exciter-monitor compartment set up as listed in paragraph 145*k*, connect the frequency counter (par. 111) to test point TP4401 on the band switch deck. Select channels 1 through 10 in that order. For each selection, the following sequence should occur:

(1) Blue STABILIZED lamp goes out.

(2) Automatic tuning mechanism operates smoothly and sets the BAND, FREQ-MC, and FREQ-KC dials to the selected setting.

(3) Blue STABILIZED lamp lights.

(4) Frequency indication on frequency counter identical with the frequency shown on the FREQ-MC and FREQ-KC dials.

b. When the modulator-oscillator is used as the exciter for Radio Frequency Amplifier AM–1154A/G, refer to paragraph 80 of TM 11–5820–350–35 for the complete service test procedure to check the range of meter readings for the 10 channels.

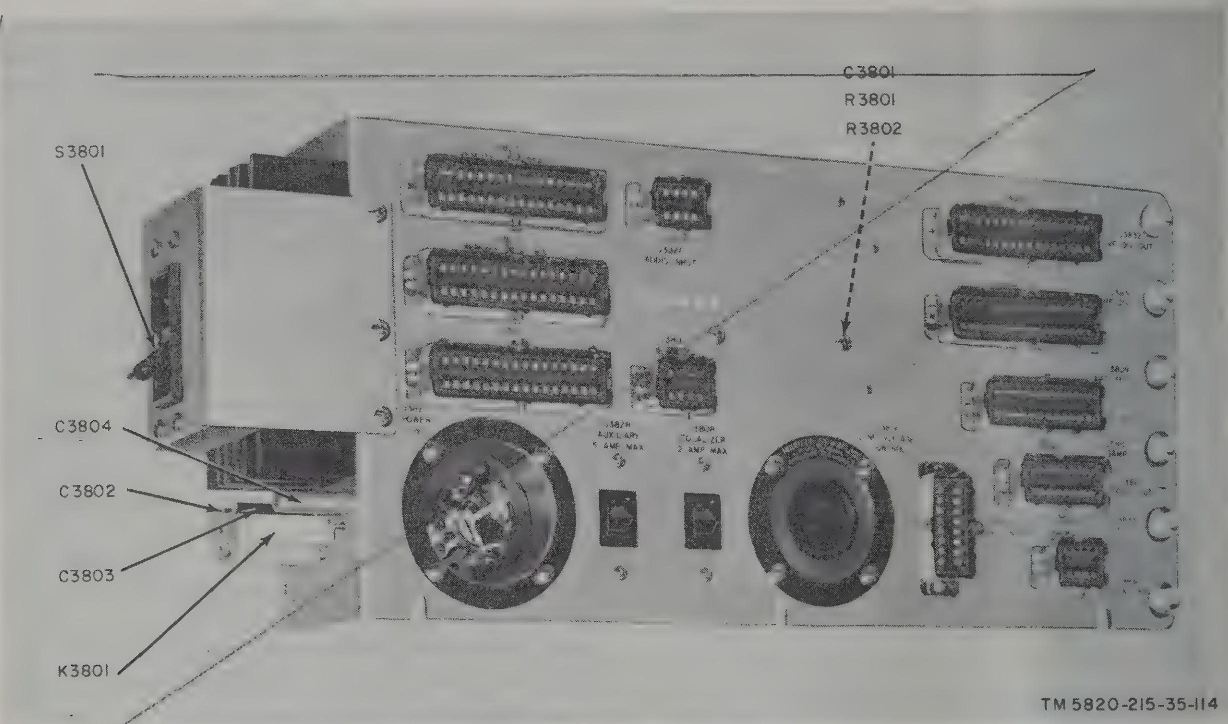


Figure 147. Main junction box.

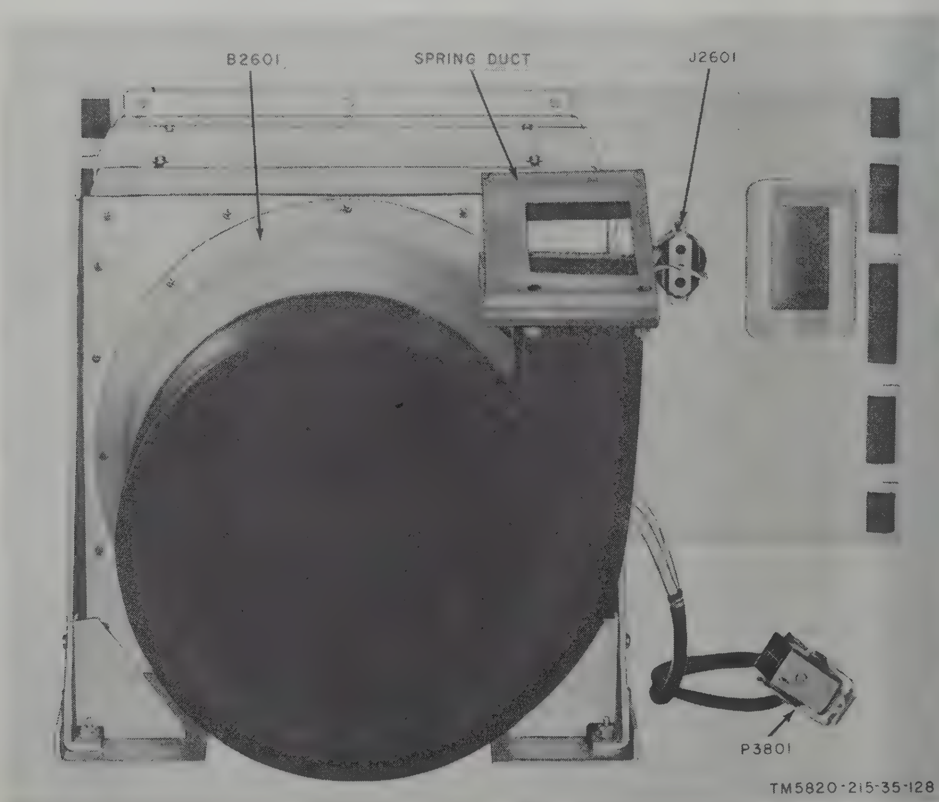
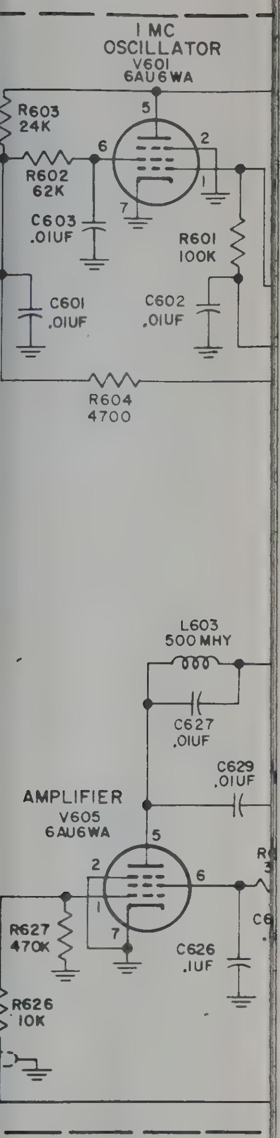


Figure 148. Blower filter assembly and motor B2601.



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VALUES ARE IN MICROMICR
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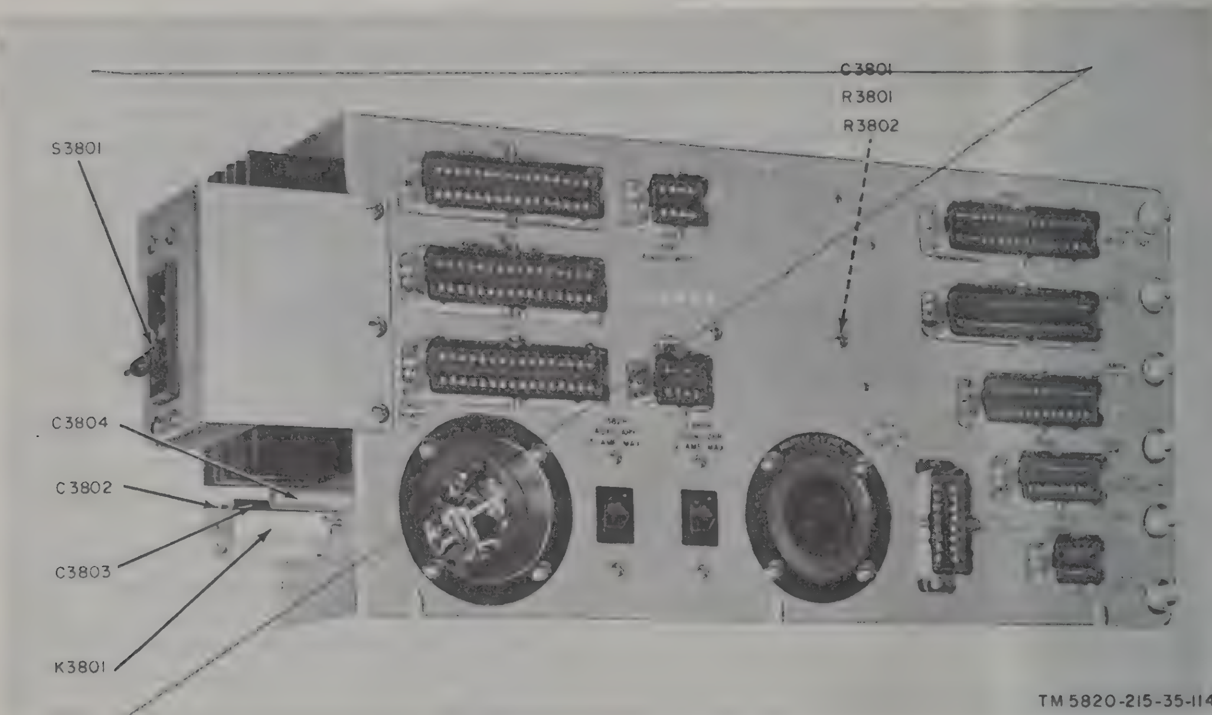


Figure 147. Main junction box.

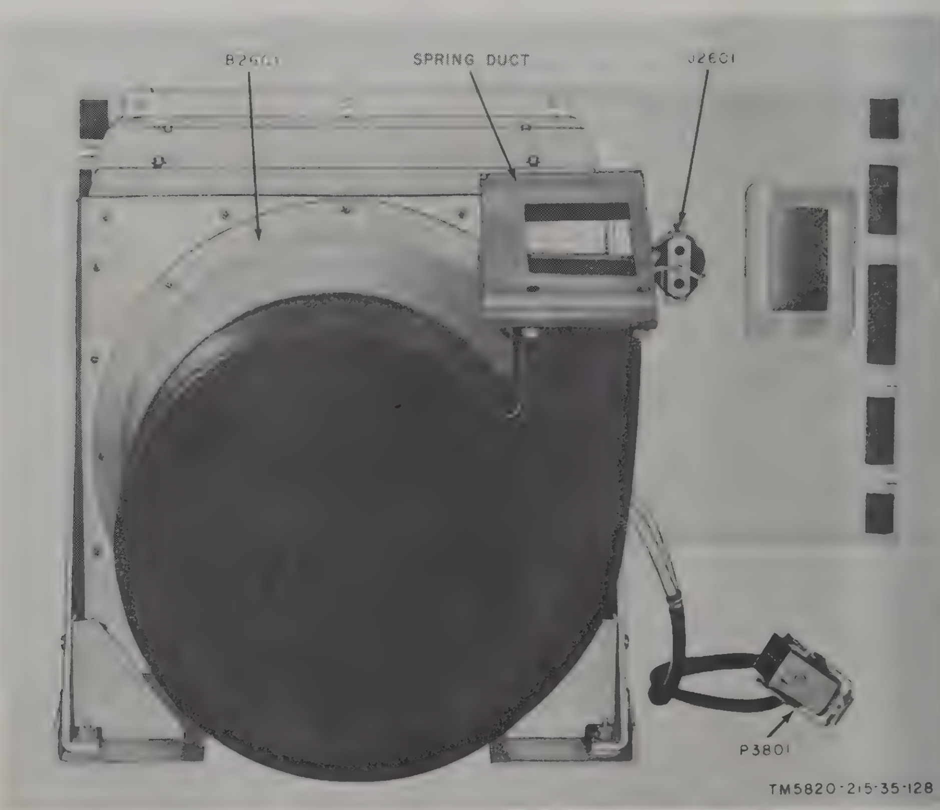
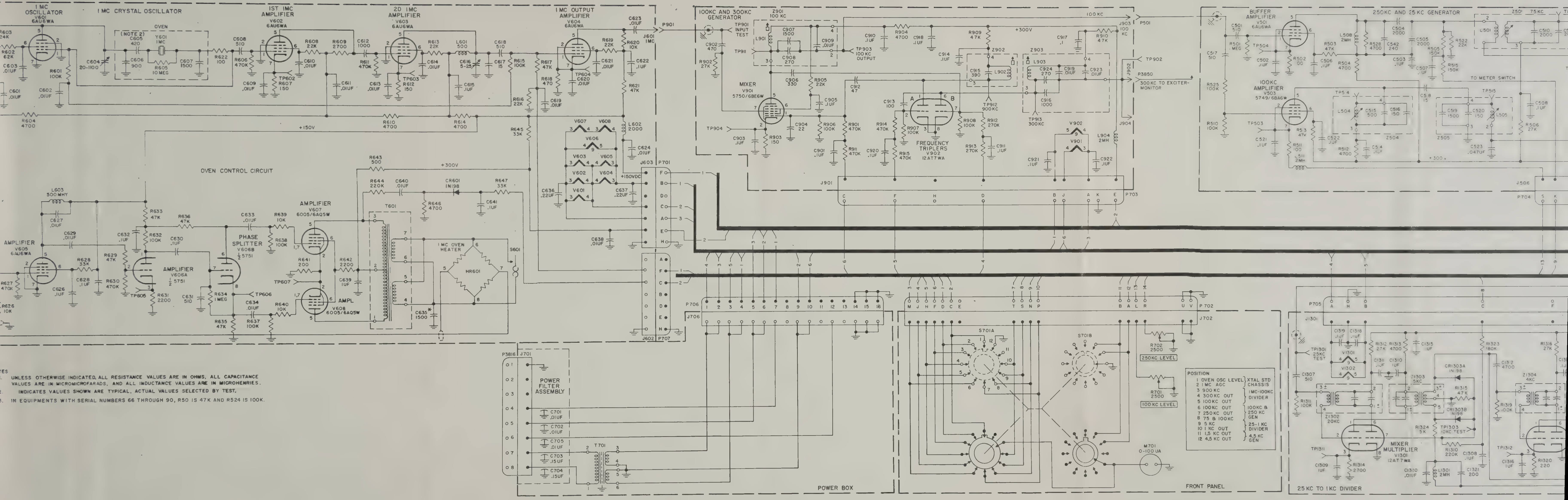


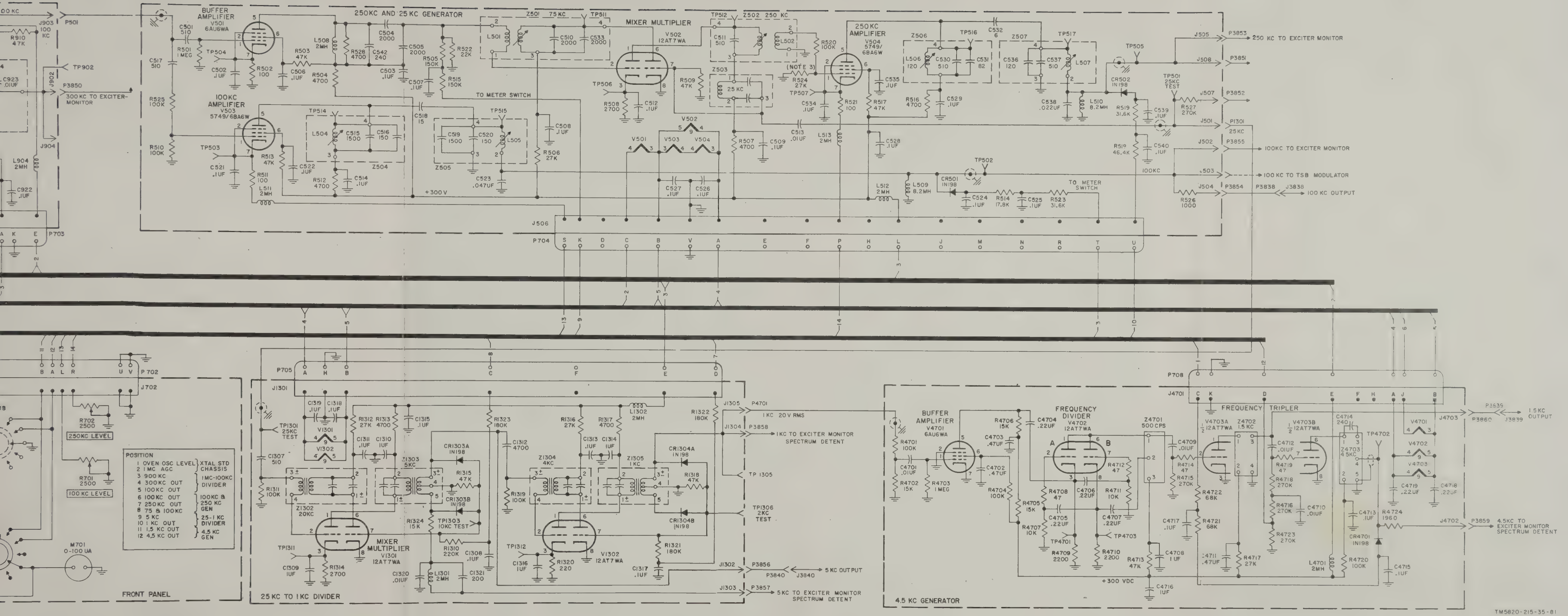
Figure 148. Blower filter assembly and motor B2601.



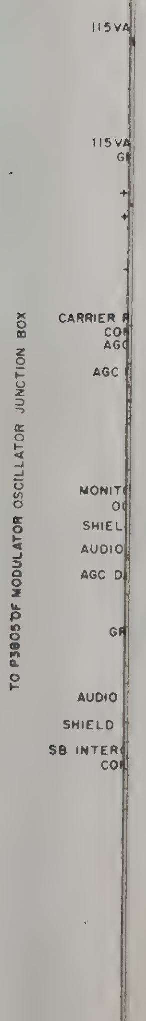
NOTES

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. * INDICATES VALUES SHOWN ARE TYPICAL, ACTUAL VALUES SELECTED BY TEST.
3. IN EQUIPMENTS WITH SERIAL NUMBERS 66 THROUGH 90, R50 IS 47K AND R524 IS 100K.

Figure 149. Frequency standard compartment, complete schematic diagram.



149. *Frequency standard compartment, complete schematic diagram.*


TO P3805 OF MODULATOR OSCILLATOR JUNCTION BOX
115VA
115VA
CARRIER
AGC
MONIT
SHIEL
AUDIO
AGC D
AUDIO
SHIELD
SB INTER

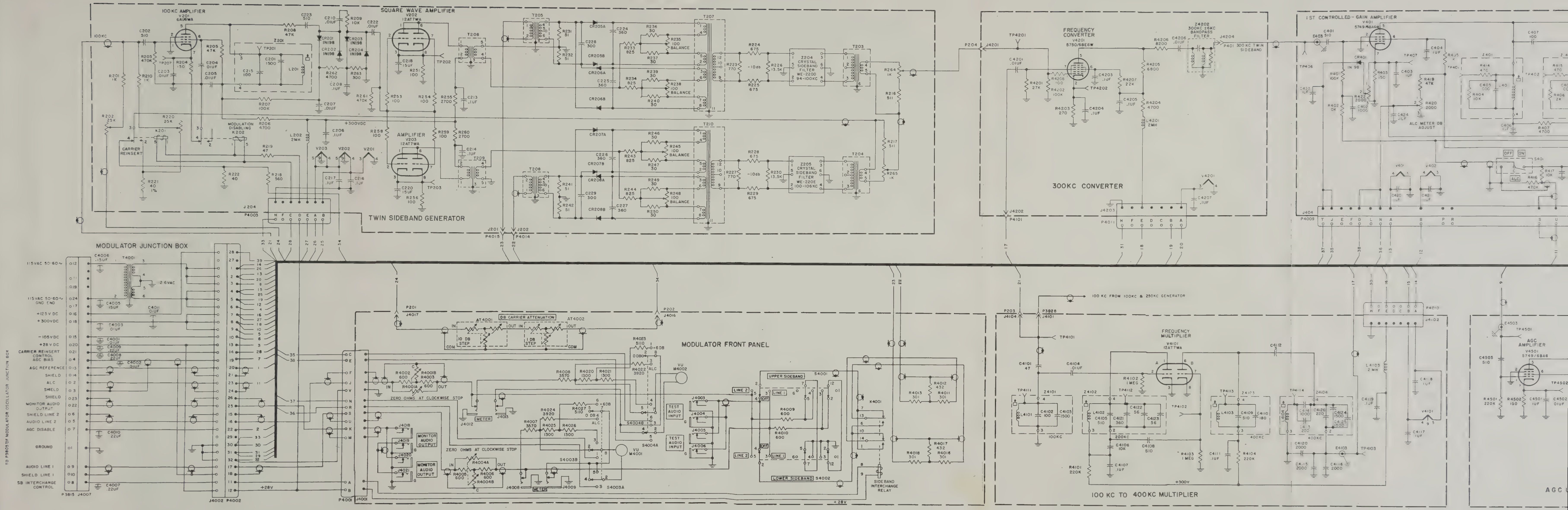


Figure 150. Twin-sideband modulator, complete schematic diagram.

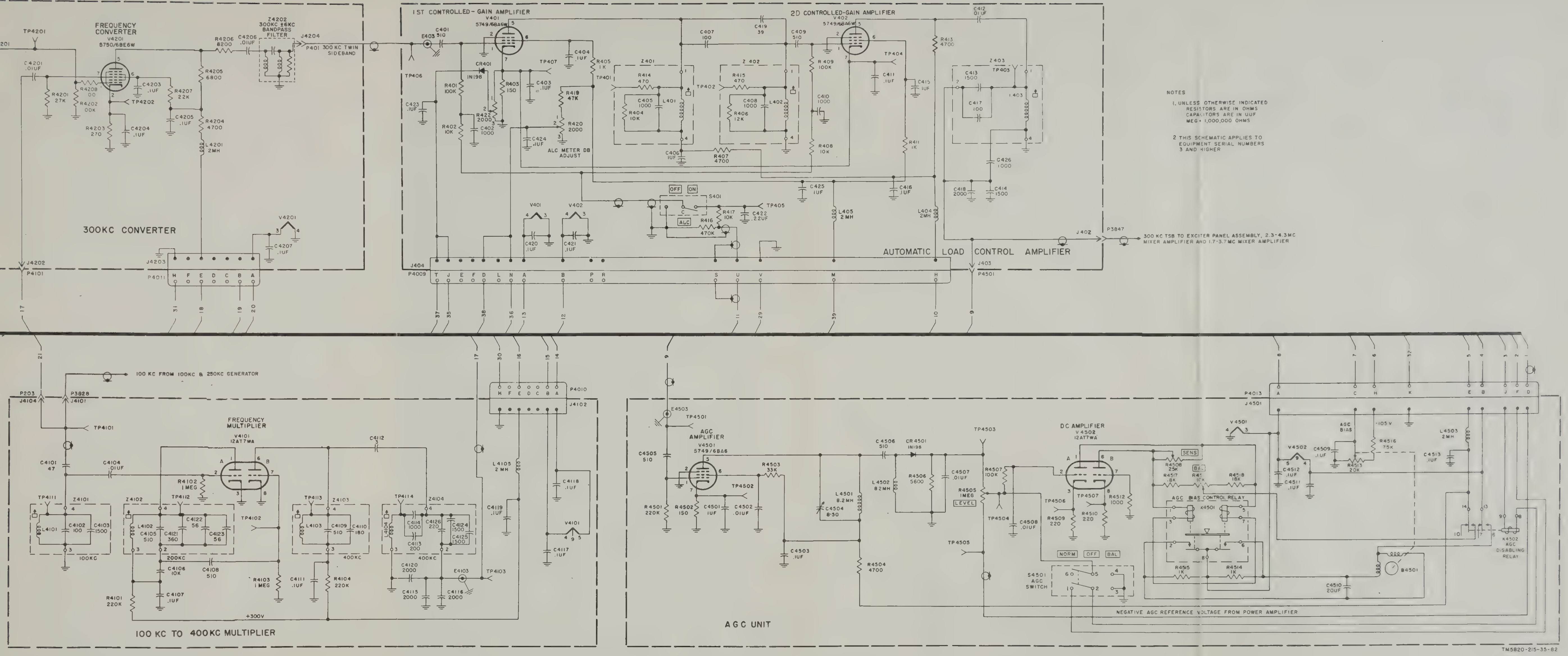
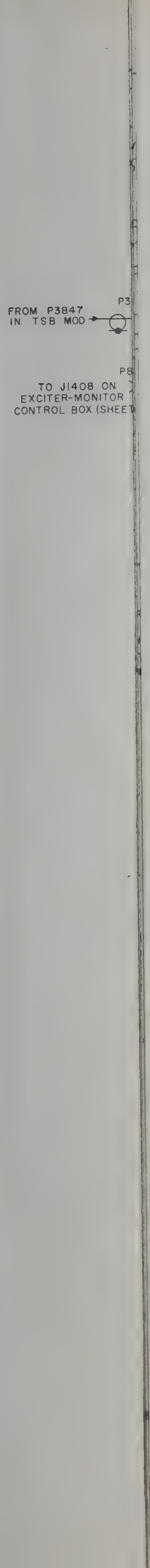


Figure 150. Twin-sideband modulator, complete schematic diagram.


P3
FROM P3847
IN TSB MOD
P8
TO J1408 ON
EXCITER-MONITOR
CONTROL BOX (SHEET

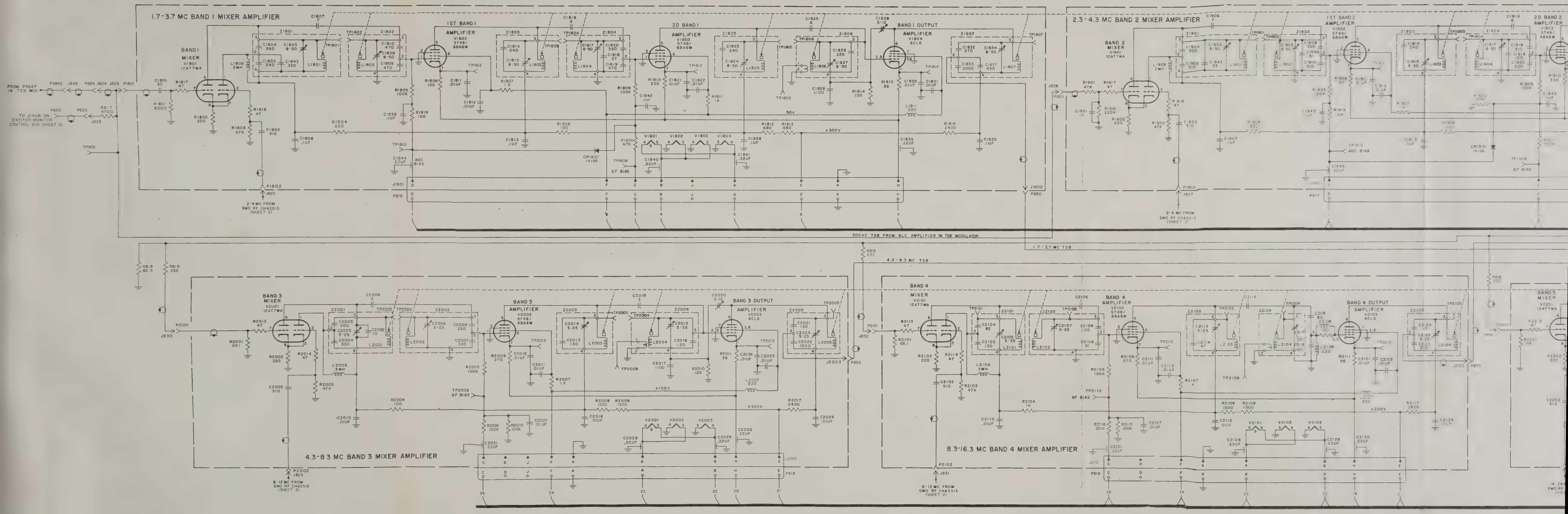
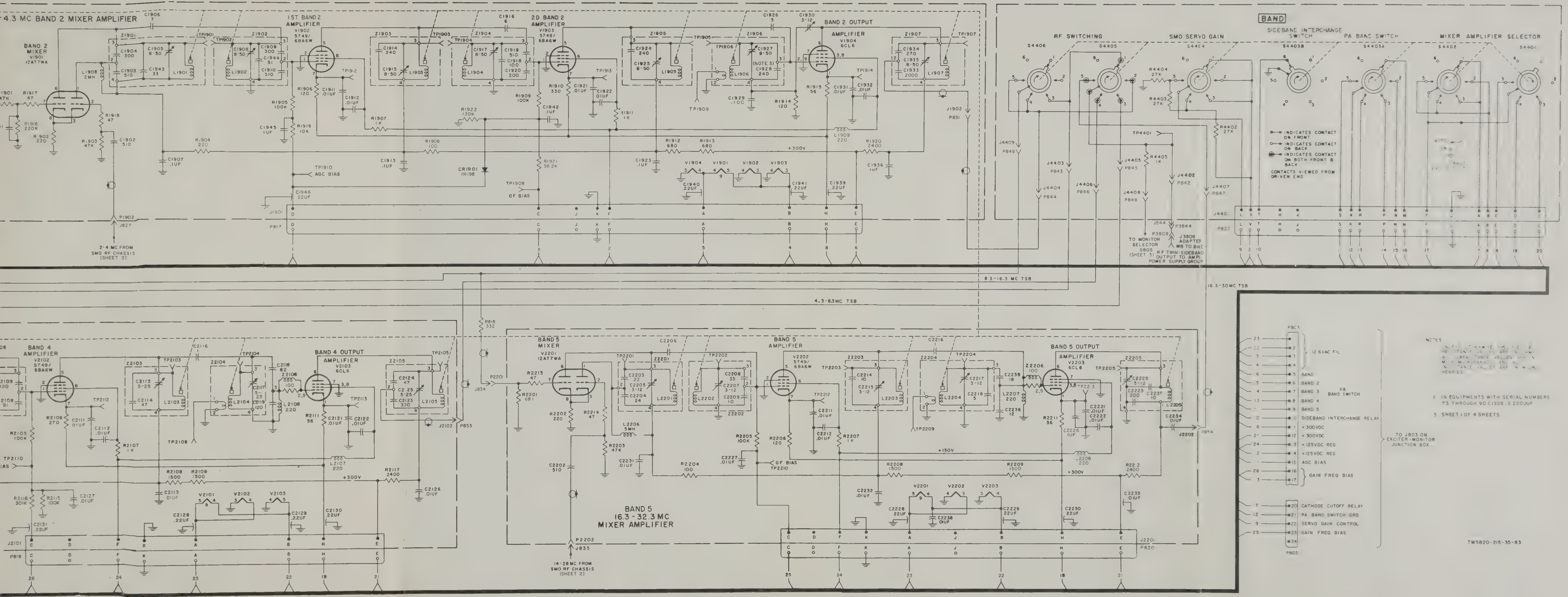


Figure 151. Exciter-monitor compartment (sheet 1 of 4): bands 1 through 5 mixer amplifiers and band switch deck, complete schematic diagram.



...xciter-monitor compartment (sheet 1 of 4): bands 1 through 5 mixer amplifiers and band switch deck, complete schematic diagram.

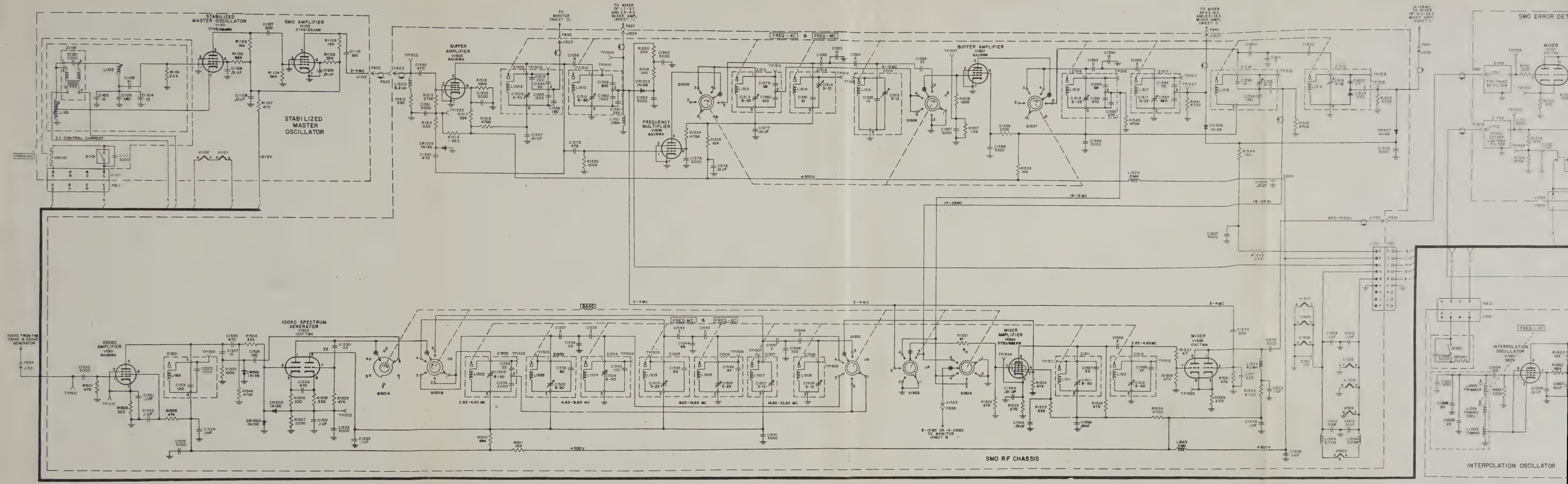


Figure 152. Exciter-monitor compartment (sheet 2 of 4): stabilized master oscillator, smo interpolation oscillator, 0.5-kc spectrum detent, and phase lock indicator chassis, complete

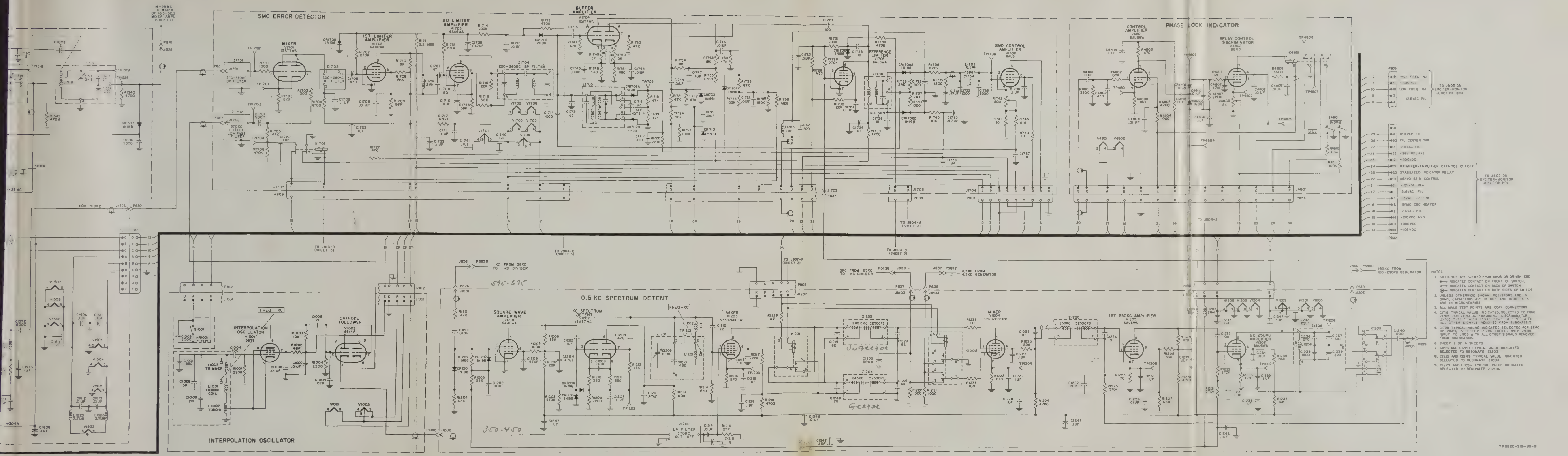
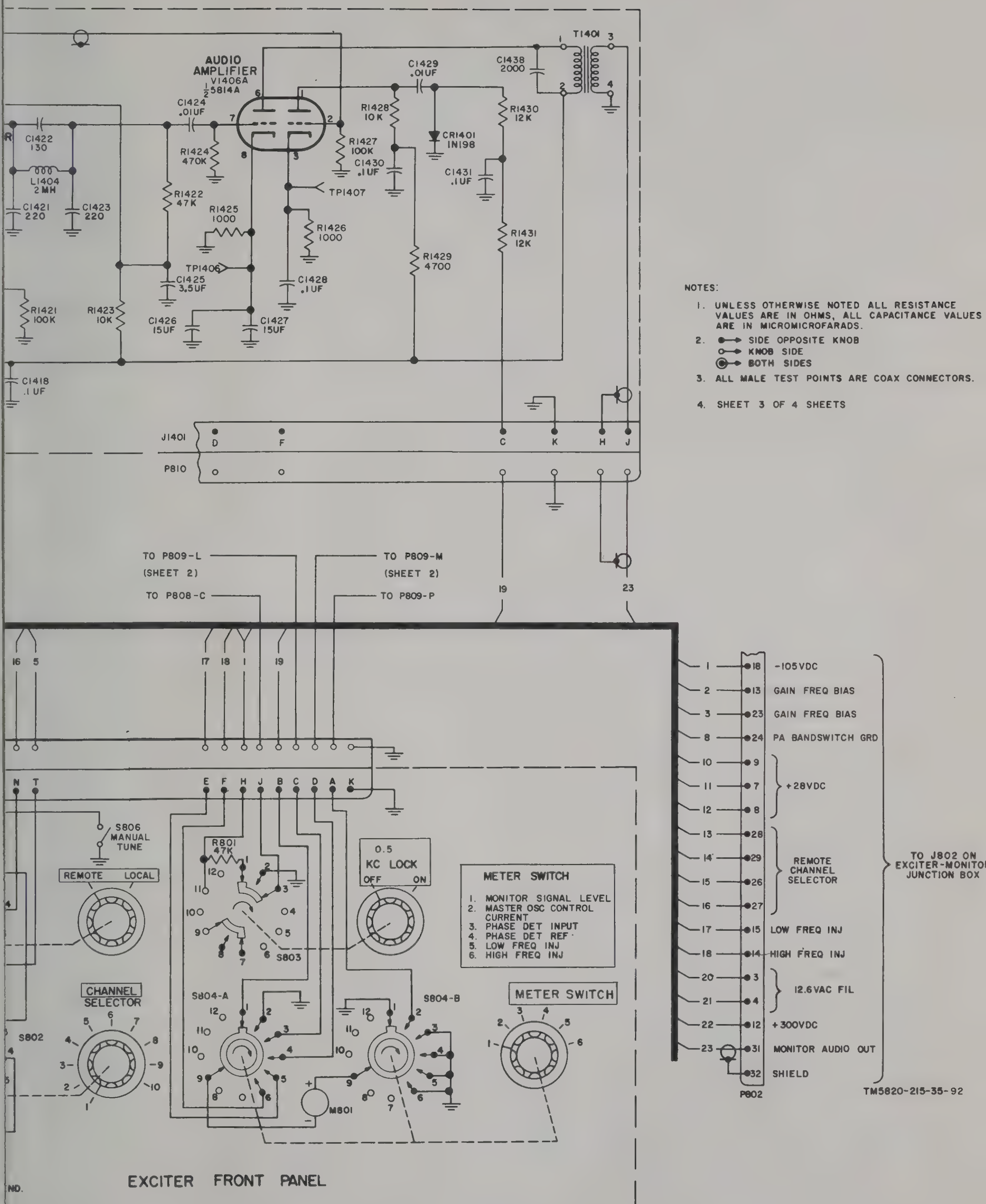


Figure 152. Exciter-monitor compartment (sheet 2 of 4): stabilized master oscillator, smo RF smo error detector, interpolation oscillator, 0.5-kc spectrum detent, and phase lock indicator chassis, complete schematic diagram.



control head,

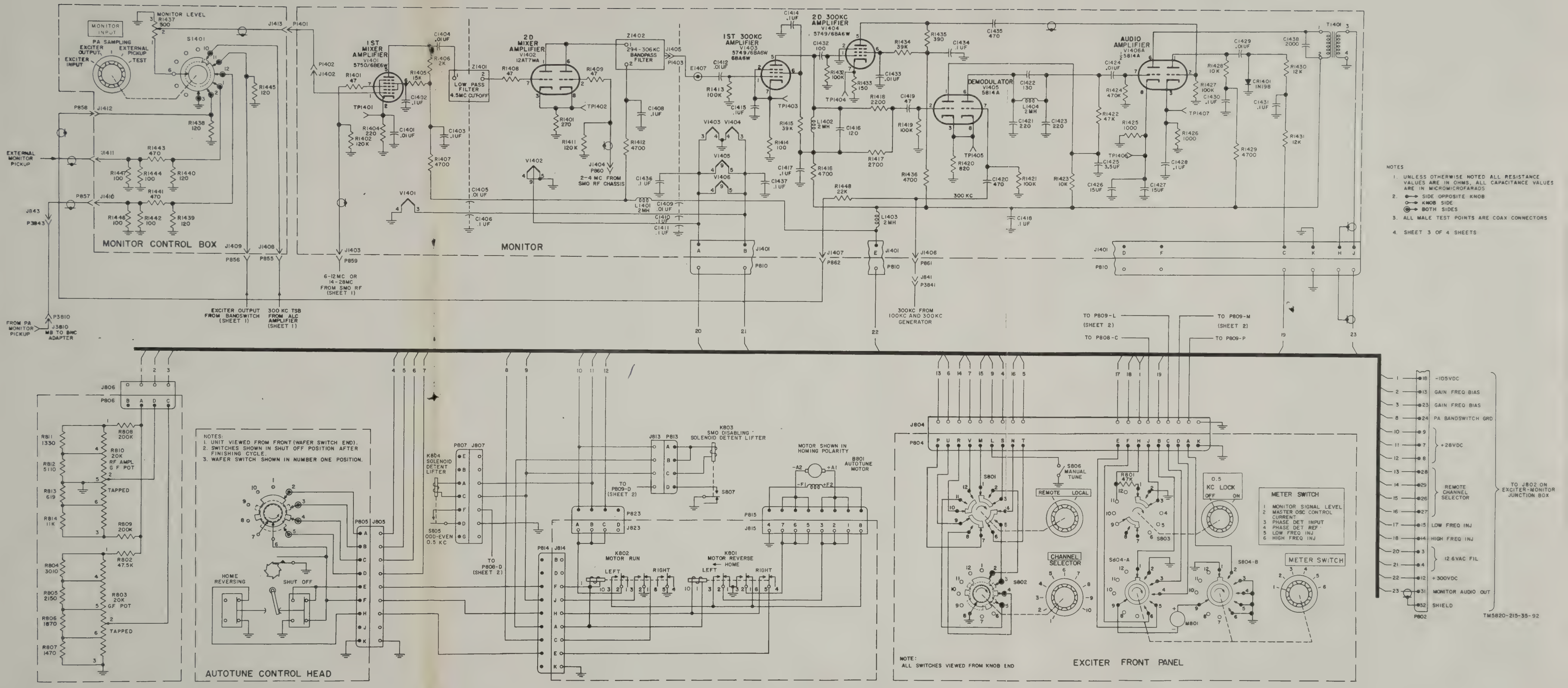
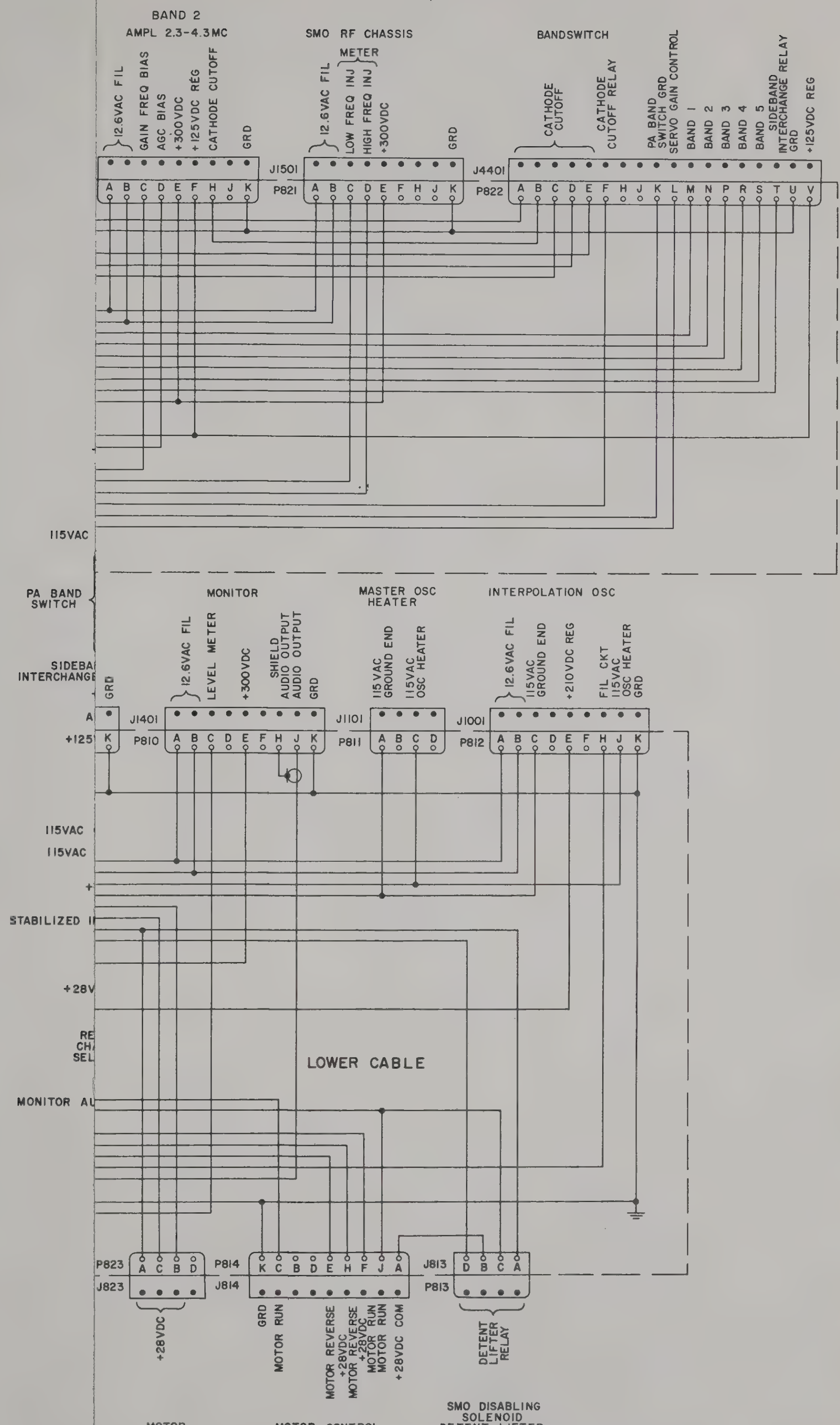


Figure 153. Exciter-monitor compartment (sheet 3 of 4): monitor chassis, front panel and automatic tuning control head, complete schematic diagram.



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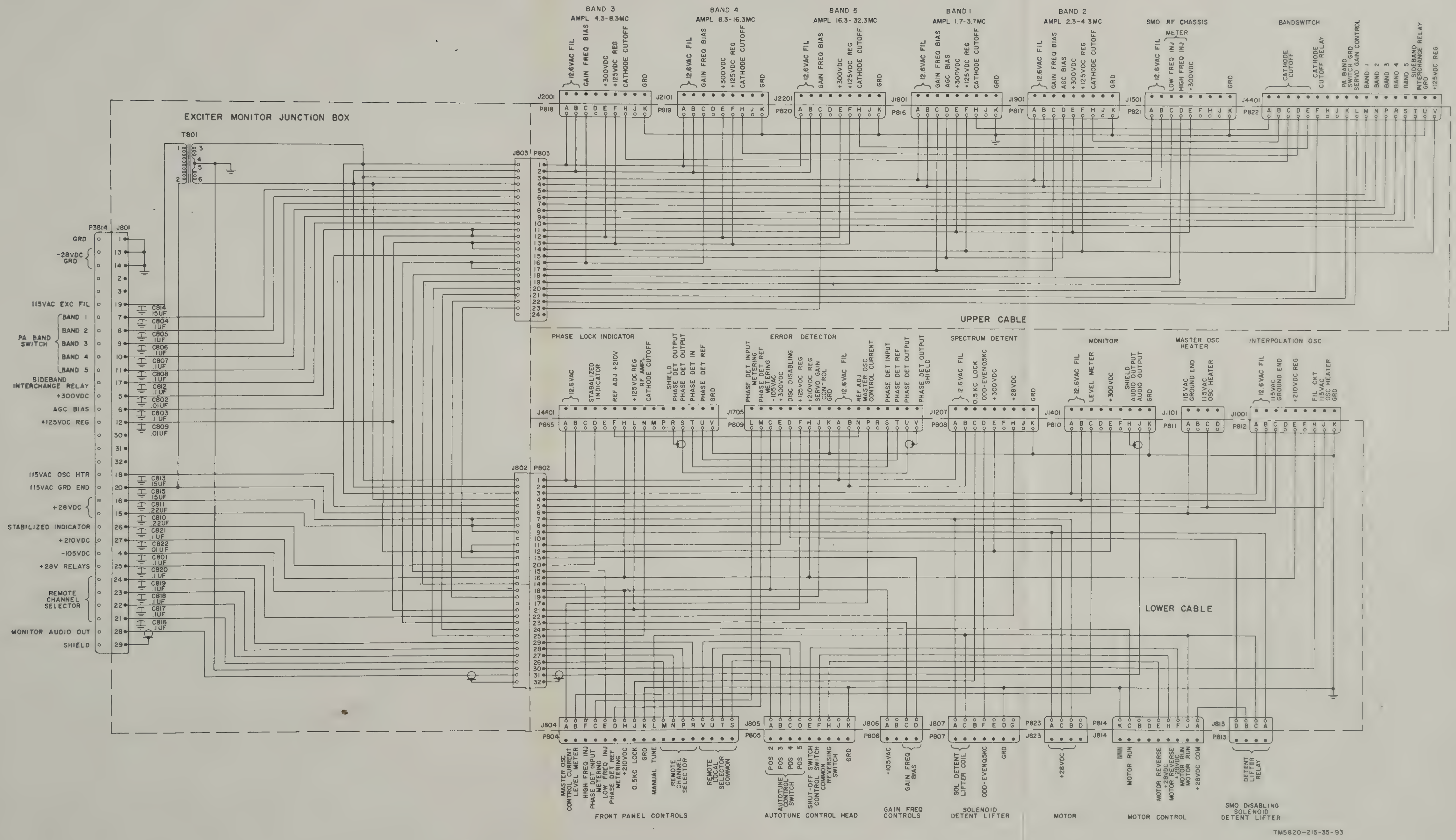
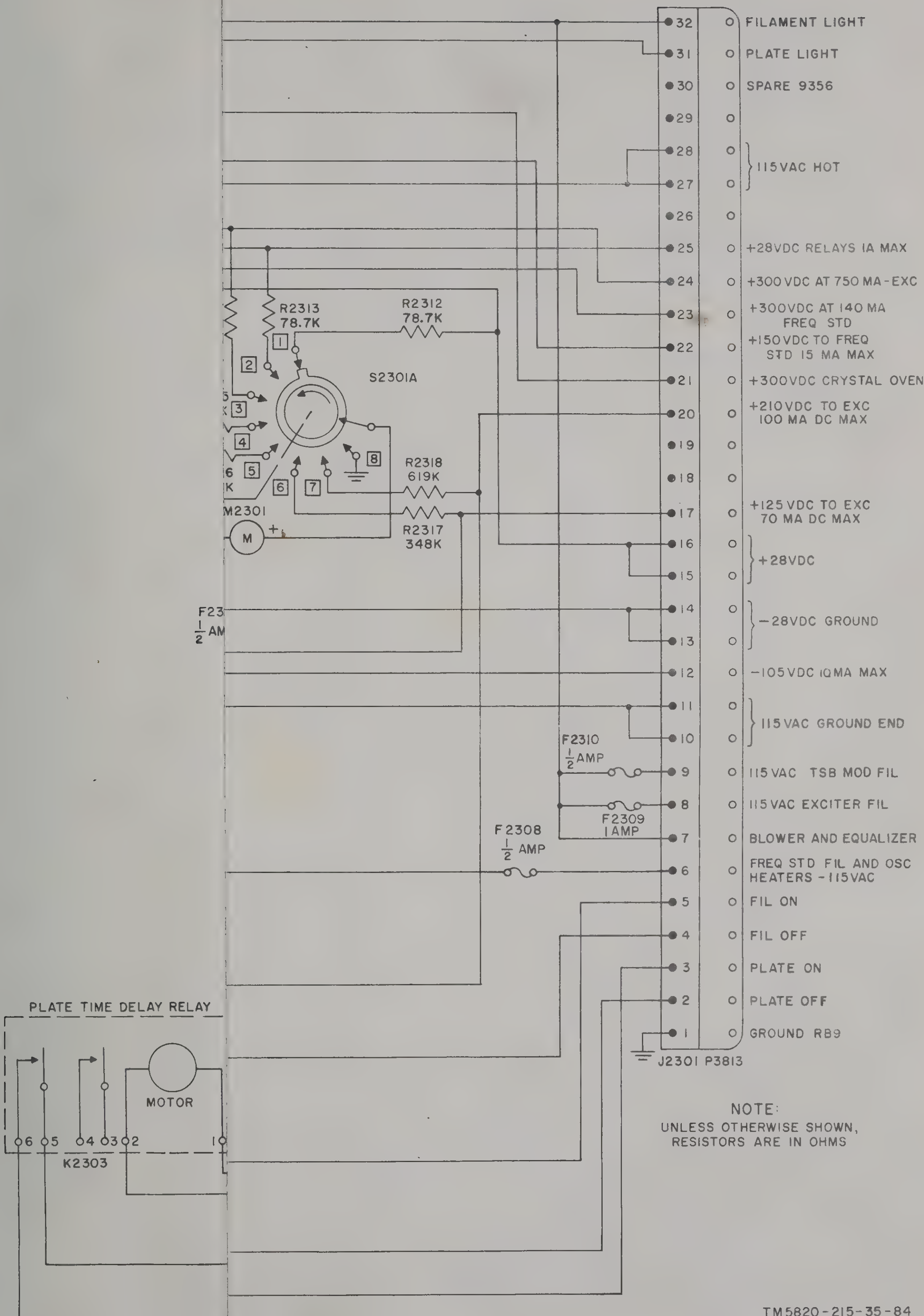


Figure 154. Exciter-monitor compartment (sheet 4 of 4): junction box wiring diagram.



NOTE:
UNLESS OTHERWISE SHOWN,
RESISTORS ARE IN OHMS

TM5820-215-35-84

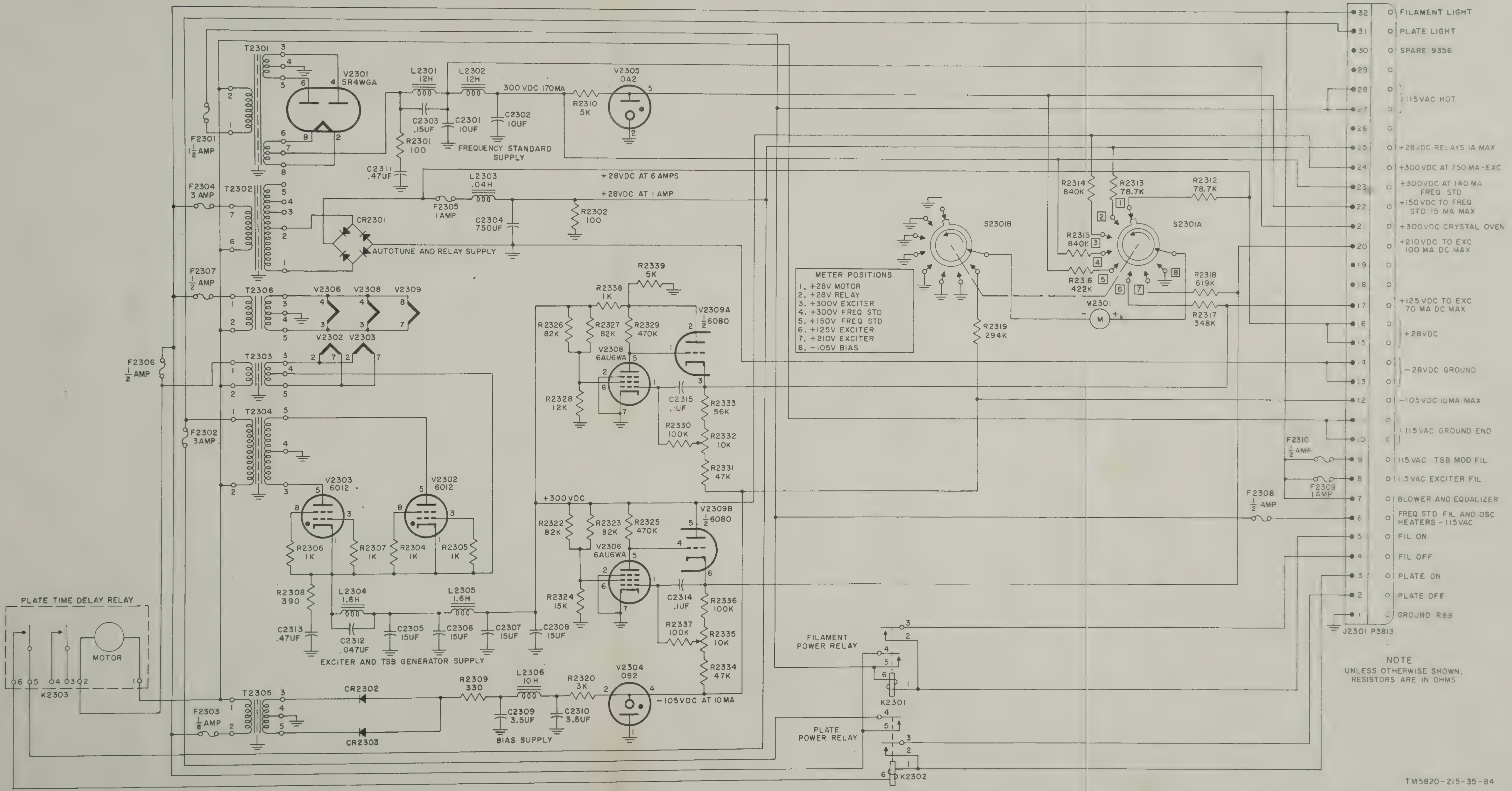
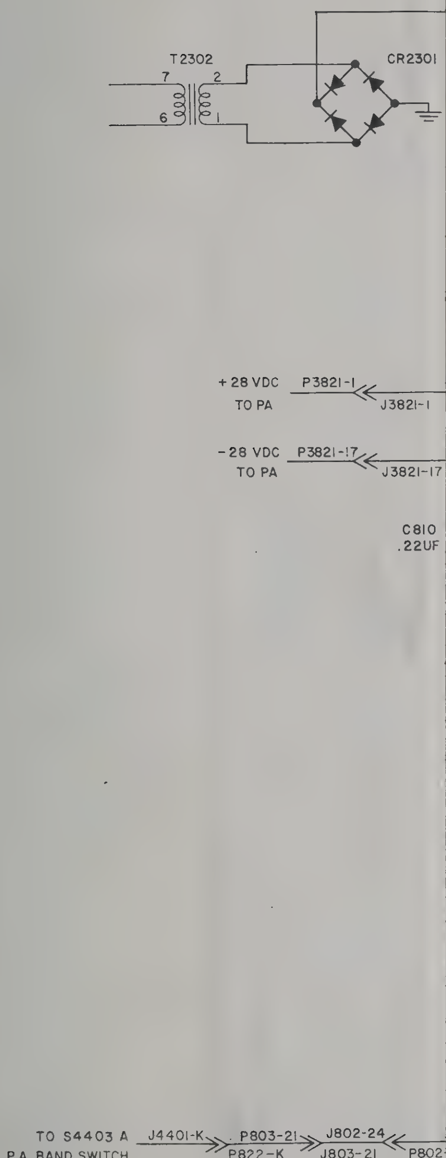
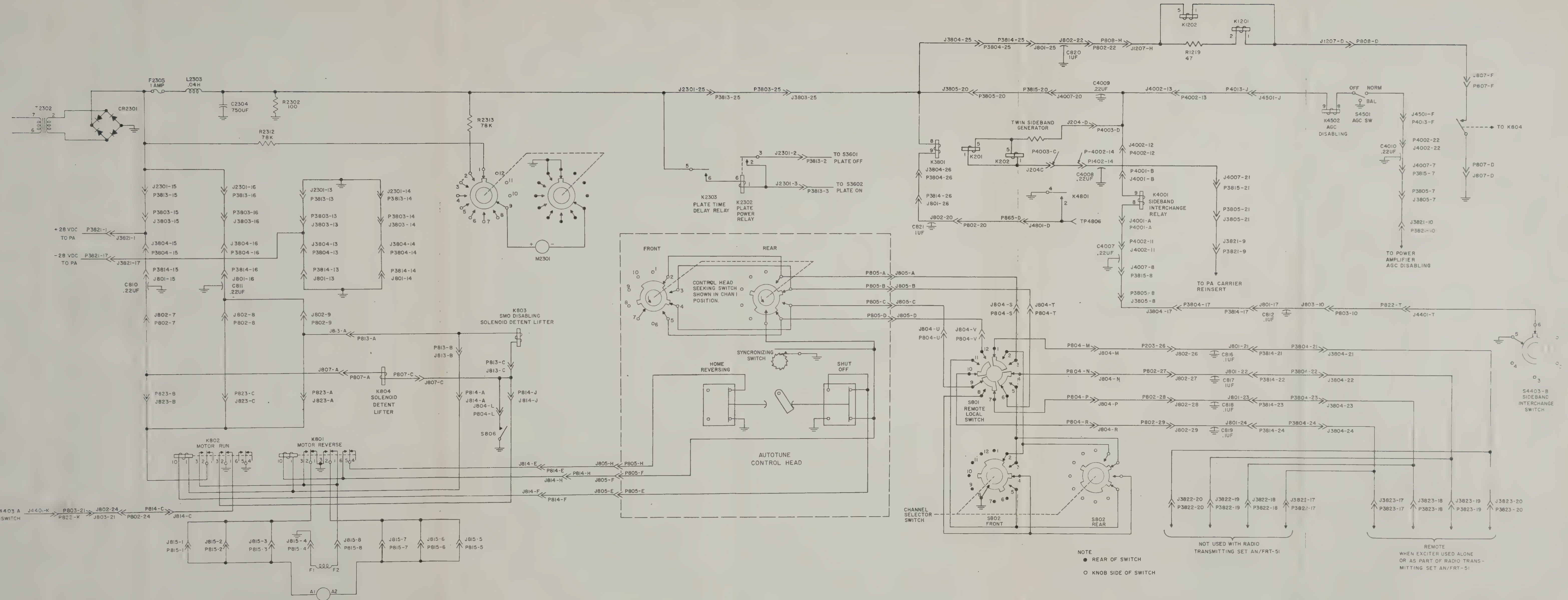


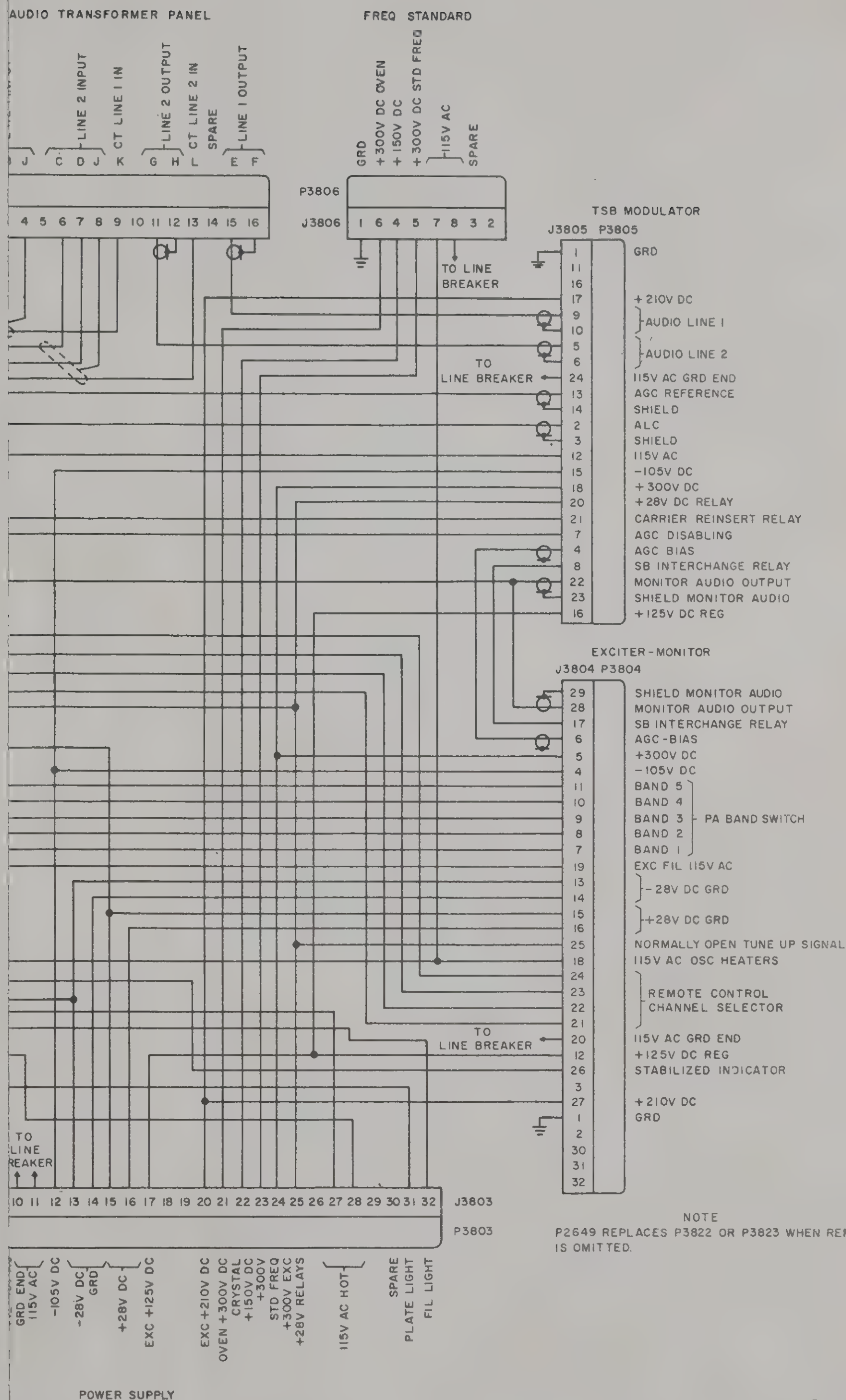
Figure 155. Power supply, complete schematic diagram.


T2302
7
2
6
1
CR2301
+28 VDC
TO PA
P3821-1
J3821-1
-28 VDC
TO PA
P3821-17
J3821-17
C810
.22UF
TO S4403 A
PA BAND SWITCH
J4401-K
P803-21
P822-K
J802-24
J803-21
P802-



TM5820-215-35-85

Figure 156. +28-volt distribution, schematic diagram.



NOTE
P2649 REPLACES P3822 OR P3823 WHEN REMOTE IS OMITTED.

TM5820-215-35-86

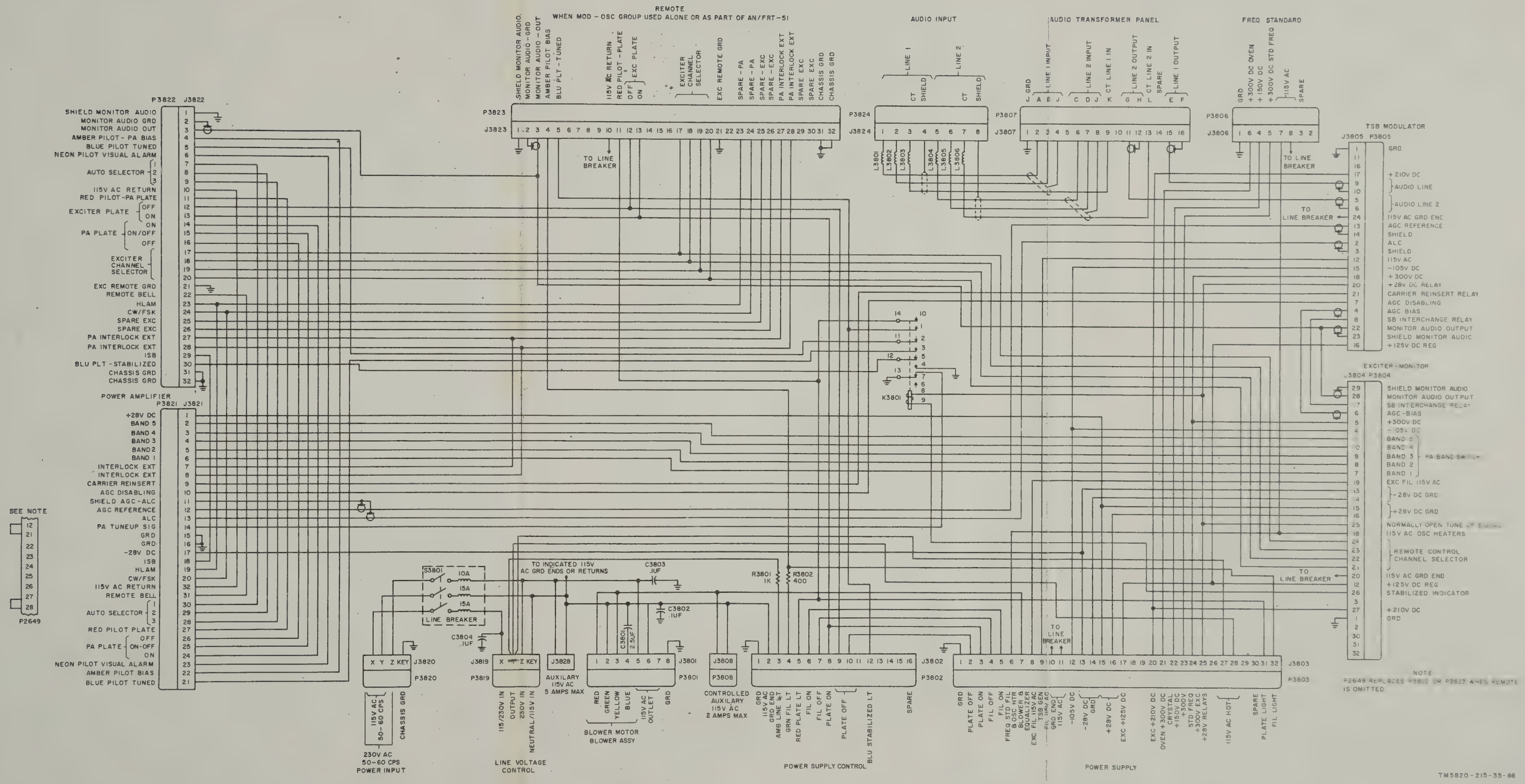


Figure 157. Main junction box, wiring diagram.

$x \cdot \frac{2}{5} \cdot 15.500$

4 . 6

8 . 4

20 : ~ ~

31 . 2 =

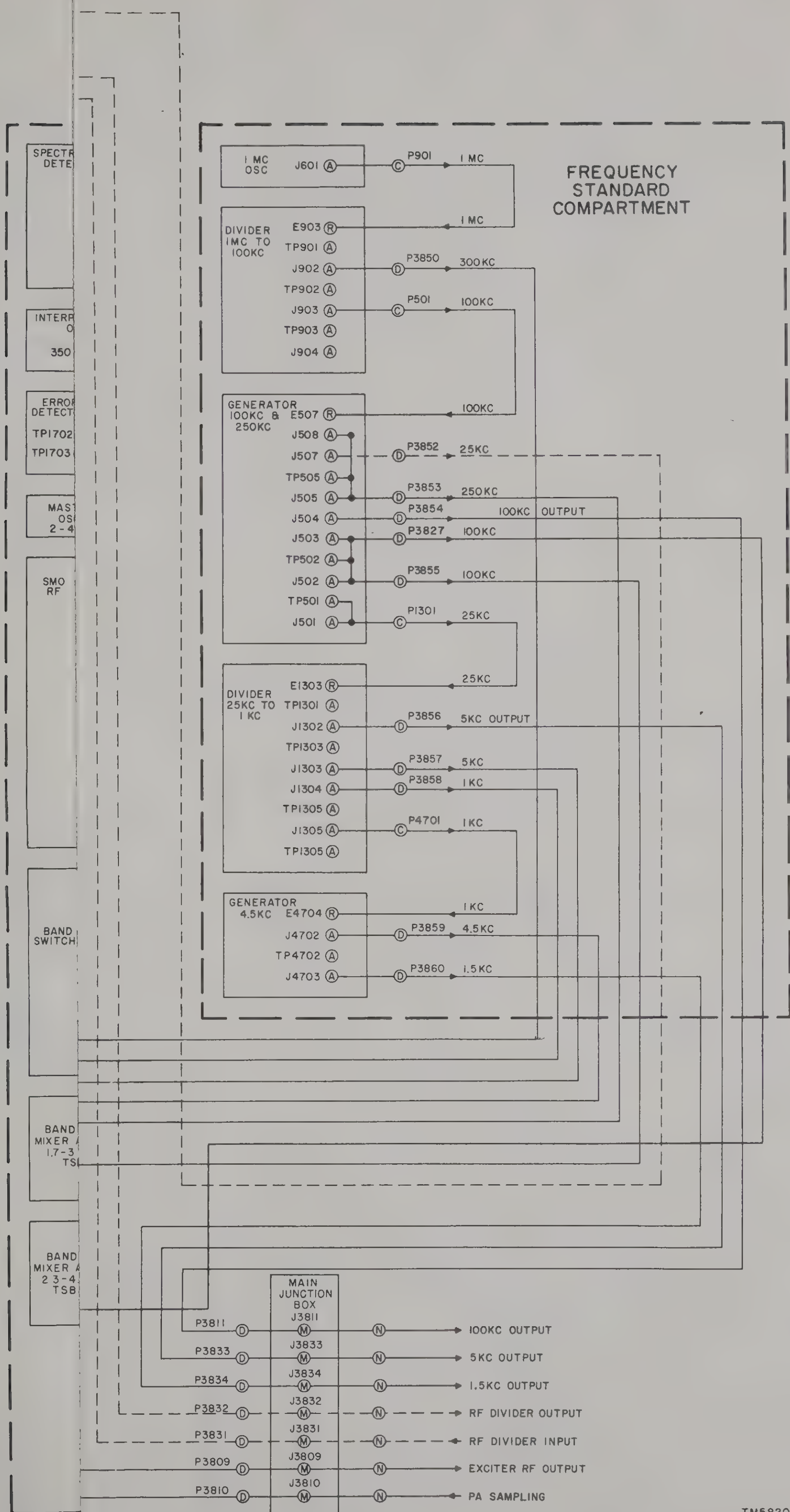
13 . 500 . 8 = 2937,5

25

30 11.5125

10 5000

40 120125 : 4 = $\underline{30031}$



TM5820-215-35-87

$x \cdot \frac{2}{5} \cdot 15.500$

4.6

8.4

20 : ..

31.2 =

23.500 : 8 = 2937,5
25
30
60
40

11.5125
5000
130125 : 4 = 30031

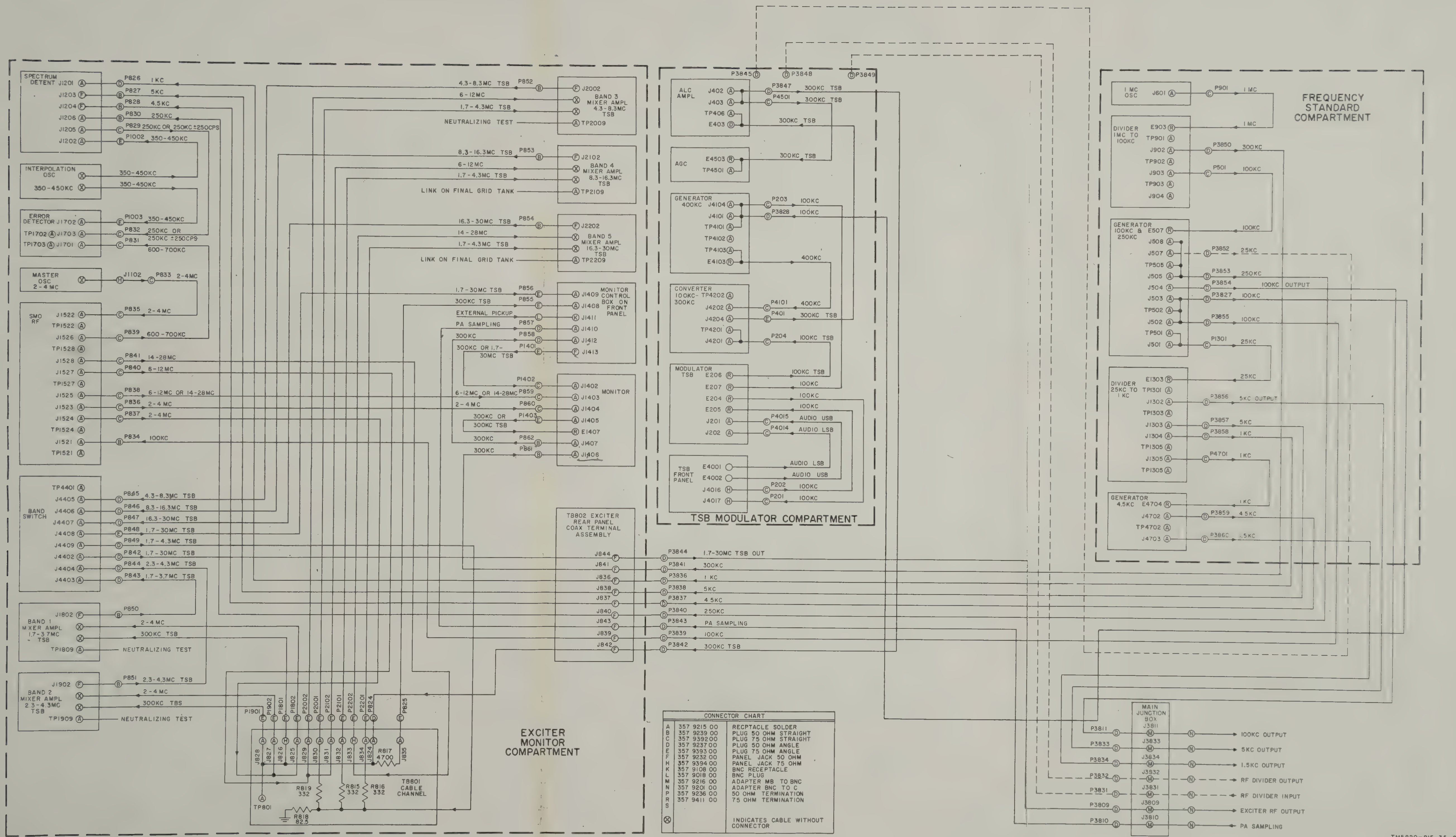
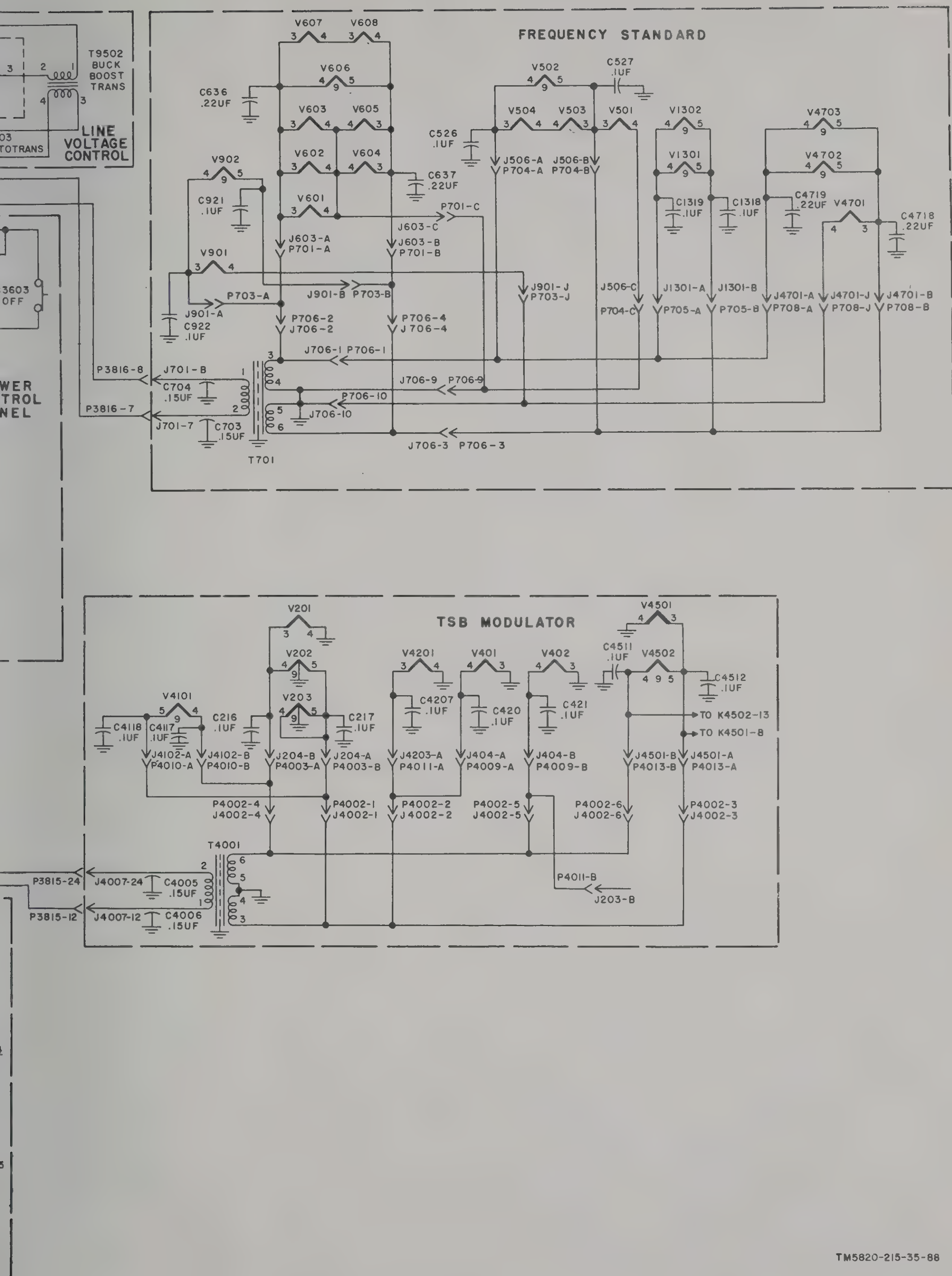


Figure 158. Coaxial cabling, wiring diagram.



TM5820-215-35-88

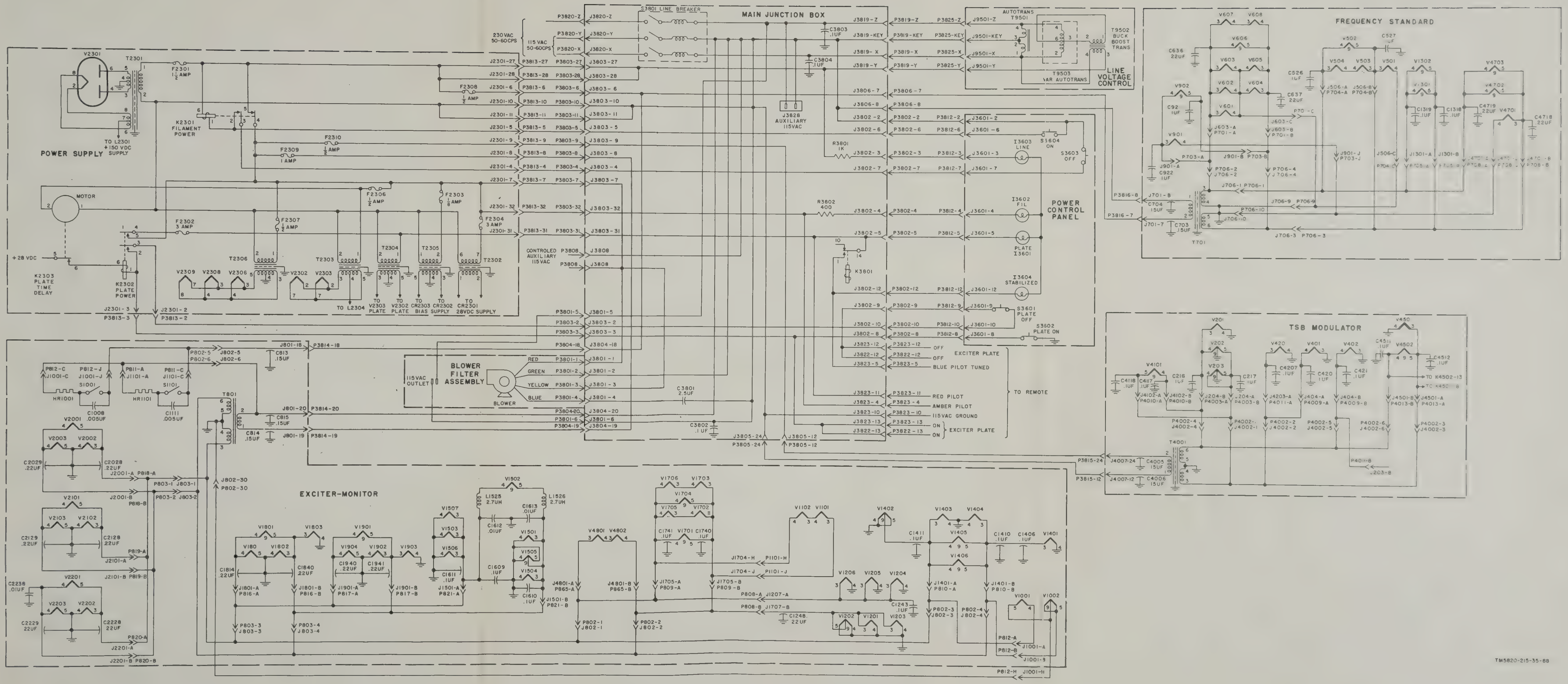


Figure 159. Primary and filament power distribution schematic diagram.

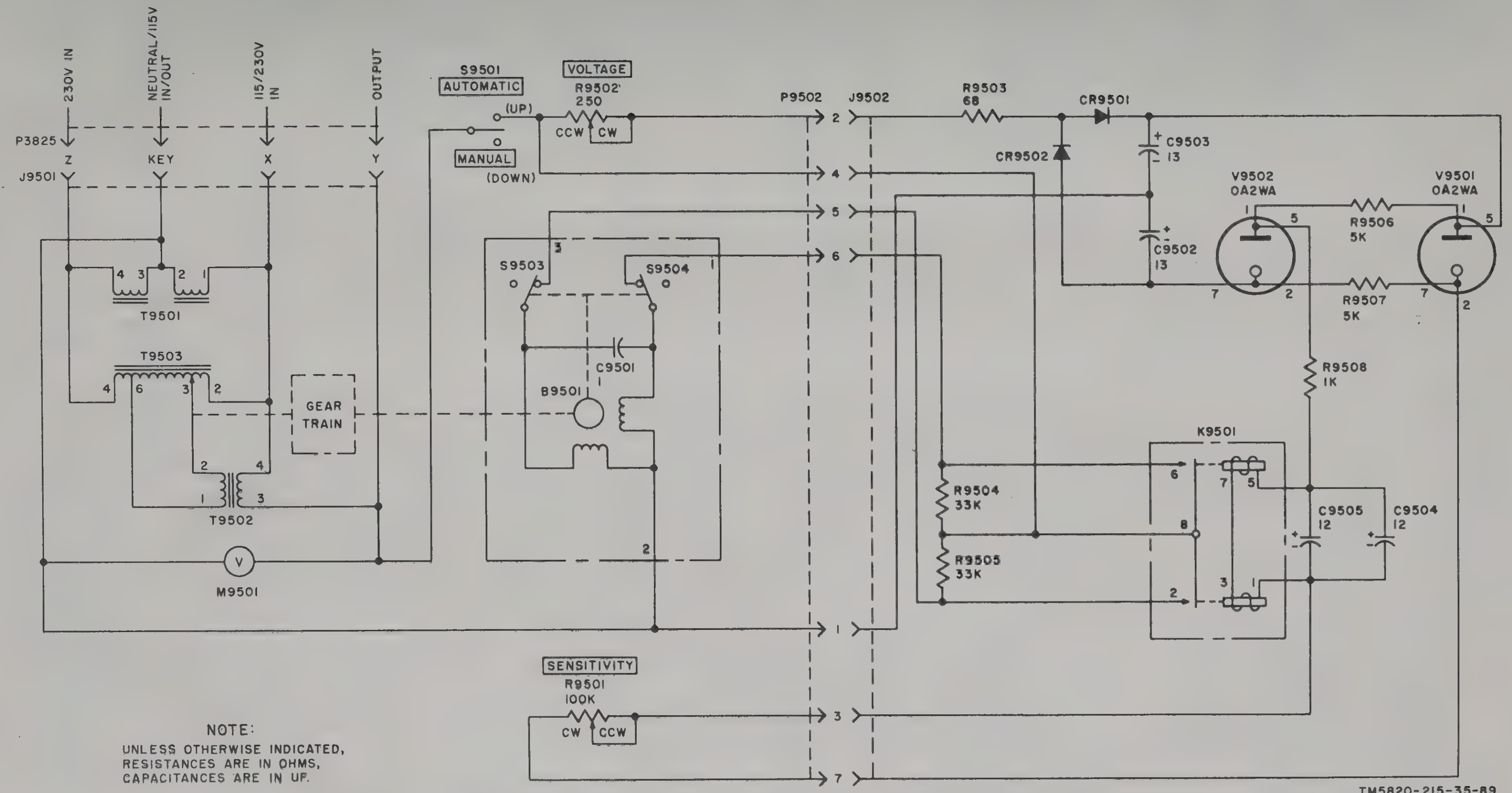


Figure 160. Automatic line voltage control panel, complete schematic diagram.

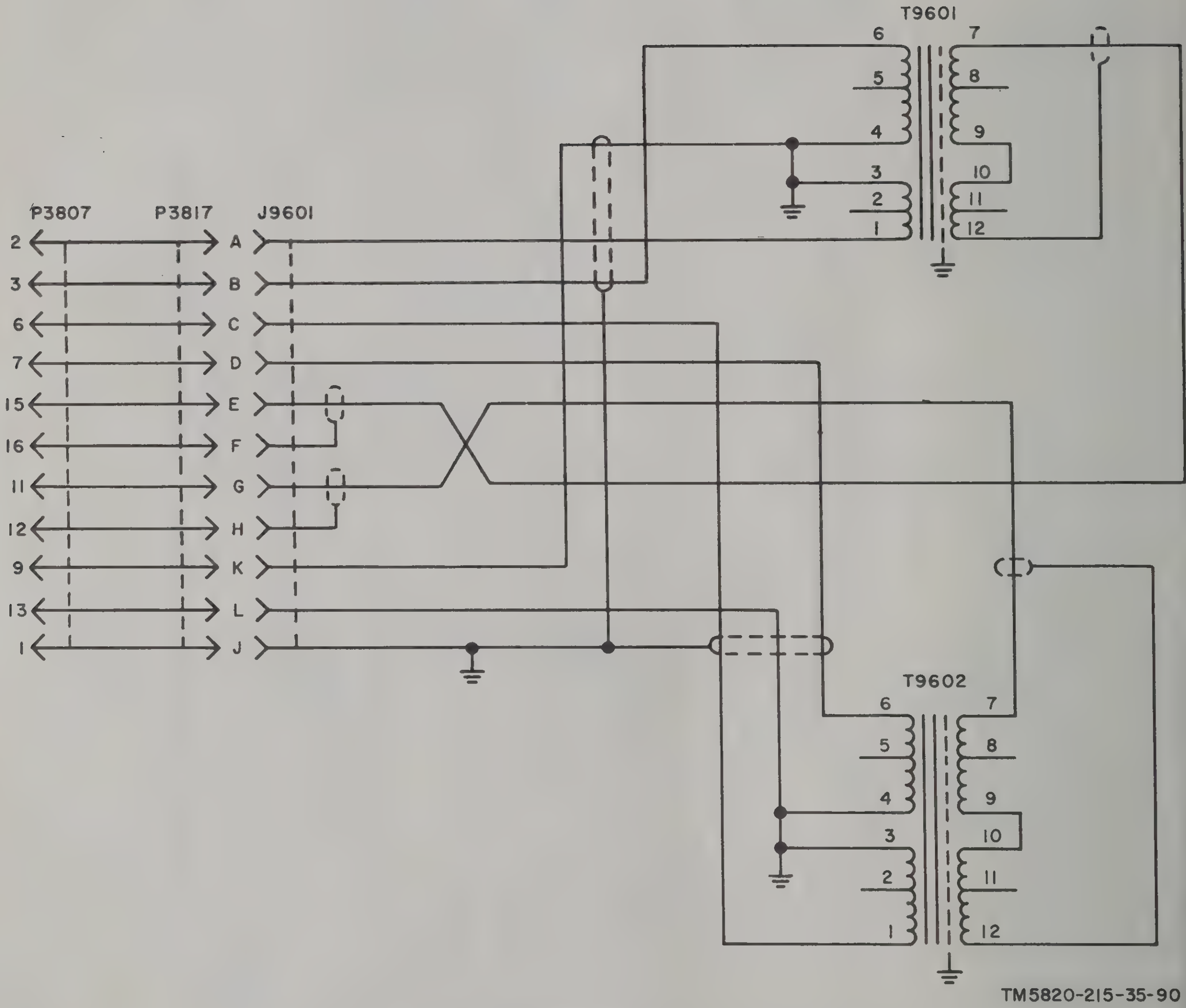
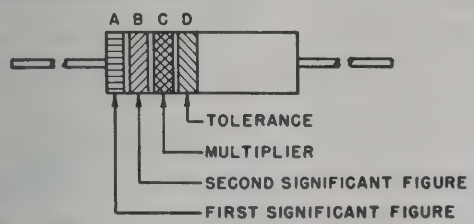


Figure 161. Audio input transformer panel, schematic diagram.

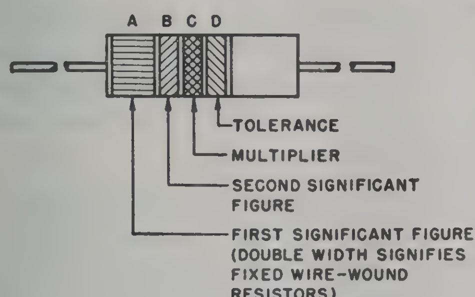
RESISTOR COLOR CODE MARKING

(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

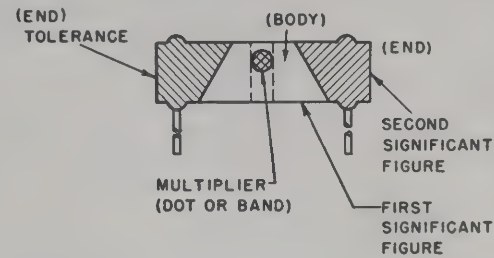


RC-COMPOSITION

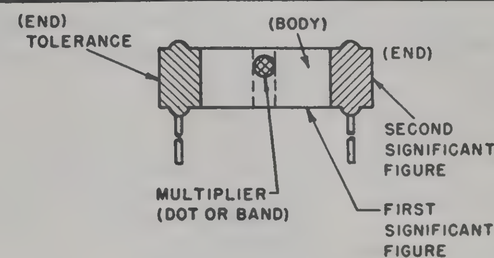


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

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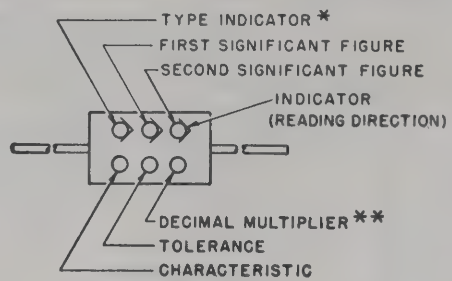
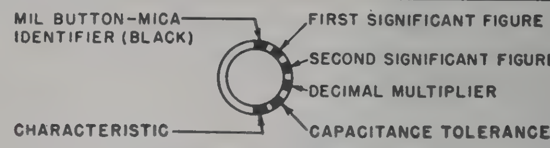
CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)

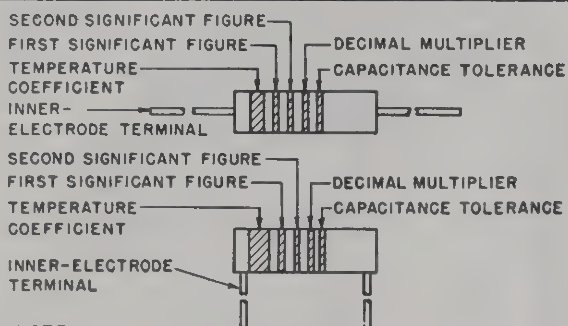


* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
**INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

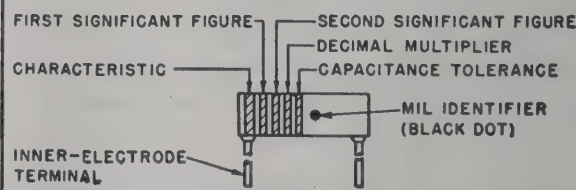


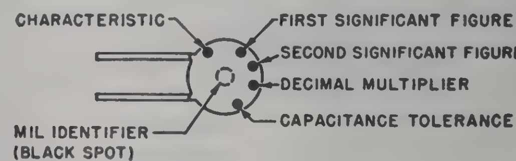
BUTTON-MICA (CB)



NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC [1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC OVER 10UUF	CC 10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

APPENDIX

REFERENCES

Following is a list of references applicable and available to the field and depot maintenance repairman of the modulator-oscillator group.

TM 11–856	Radio Receiver R–390/URR.
TM 11–1214	Instruction Book for Oscilloscope OS–8A/U.
TM 11–2661	Electron Tube Test Sets TV–2/U, TV–2A/U, and TV–2B/U.
TM 11–5083	Electron Tube Test Sets TV–7/U, TV–7A/U, and TV–7B/U and TV–7D/U.
TM 11–5094	Frequency Meters AN/URM–79 and AN/URM–82.
TM 11–5095	Frequency Meter AN/URM–80.
TM 11–5097	Spectrum Analyzers TS–723A/U and TS–723/U.
TM 11–5114	Panoramic Indicator IP–259/U.
TM 11–5132	Voltmeter, Meter ME–30A/U and Voltmeters Electronic ME–30B/U and ME–30C/U.
TM 11–5820–215–20P	Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart: Modulator-Oscillator Group OA–2180/FRT–51.
TM 11–5820–215–35P	Field and Depot Maintenance Repair Parts and Special Tools List: Modulator-Oscillator Group OA–2180/FRT–51.
TM 11–5820–218–12	Frequency Meter AN/TSM–16, Operation and Organizational Manual.
TM 11–5820–350–35	Radio Frequency Amplifier AM–1154A/G, Power Supply PP–1234/G, and Control Amplifier C–1637A/GR, Field and Depot Maintenance Manual.
TM 11–5821–212–10	Radio Transmitting Set AN/FRT–51, Operator's Manual.
TM 11–5821–212–20	Radio Transmitting Set AN/FRT–51, Organizational Maintenance.
TM 11–5821–215–10P	Operator's Maintenance Repair Parts and Special Tools List for Modulator-Oscillator Group OA–2180/FRT–51.

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For explanation of abbreviations used, see AR 320–50.

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